

Historical Perspectives

Purposeful Porpoise Training at Fjord&Bælt: The First 25 Years

Magnus Wahlberg,^{1,2} Mats Amundin,³ Kirstin Anderson Hansen,^{1,2}
Søren Hechmann Andersen,⁴ Marie-Anne Blanchet,⁵ Sabrina Brando,⁶
Andreas Brogaard Buhl,⁷ Geneviève Desportes,⁸ Sabina Fobian Hansen,⁹
Christina Lockyer,¹⁰ Lee A. Miller,¹ Marianne Rasmussen,¹¹
Ursula Siebert,¹² and Mette Thybo²

¹Marine Biological Research Center, University of Southern Denmark,
Hindsholmvej 11, 5300 Kerteminde, Denmark

E-mail: magnus@biology.sdu.dk

²Fjord&Bælt, Margrethes Plads 1, 5300 Kerteminde, Denmark

³Kolmården Wildlife Park, 61892 Kolmården, Sweden

⁴Korsvejs Alle 23A, 5500 Middelfart, Denmark

⁵Norwegian Polar Institute, Framsenderet, 9296 Tromsø, Norway

⁶AnimalConcepts, 03725 Teulada, Spain

⁷NIRAS, Sortemosevej 19, 3450 Allerød, Denmark

⁸NAMMCO, Forskningsparken, Sykehusvegen 21-23, 9278 Tromsø, Norway

⁹Mågevej 5, 5800 Nyborg, Denmark

¹⁰AgeDynamics, Kongens Lyngby, 2800 Copenhagen, Denmark

¹¹The University of Iceland's Research Center in Húsavík, Hafnarstétt 3, 640 Húsavík, Iceland

¹²Institute for Terrestrial and Aquatic Wildlife Research, University of Veterinary Medicine Hannover,
Werftstrasse 6, 25761 Büsum, Germany

Abstract

During the past 25 years, Fjord&Bælt (F&B) in Denmark has kept harbour porpoises (*Phocoena phocoena*) for research and education. Some animals were bycaught in static fishing gear and then brought to the center under a special permit, and some were born at the facility. At F&B, the harbour porpoises are trained several times every day for research projects, public presentations for visitors, and educational programs for schools. They are also provided with enrichment activities in addition to the enclosure's natural and dynamic habitat. The center's research on animal behaviour, reproductive and diving physiology, outreach, and bioacoustics have resulted in more than 60 scientific publications, involving scientists from research institutions in Denmark and abroad. There is a close collaboration between F&B and the adjacent Marine Biological Research Center (MRC) of the University of Southern Denmark (SDU), also established in 1997.

Origins

The idea of establishing a marine research and outreach center in Kerteminde dates to the early 1990s when the University of Southern Denmark (SDU) was searching for a new location for its marine ecology and ecotoxicology programs. Simultaneously, the Kerteminde municipality was interested in establishing an outreach center to promote the town's tourist portfolio, as well as in developing teaching activities for school classes near and far. Ideas converged upon using a location in Kerteminde harbour, both as a laboratory and as an education center. The emphasis was to make visitors understand how unique and beautiful the local marine environment is. An underwater tunnel, containing windows to the local underwater world, was included in the center's plans. The visitors would participate in hands-on activities for all the senses and directly observe research projects in the making.

By 1995, funding had been secured, and construction started. In the original drawings of the center, it was understood that everything towards the harbour side and beyond the tunnel would be



Fjord&Bælt (right) and the Marine Biological Research Center (left). The harbour porpoise (*Phocoena phocoena*) pool is visible to the right, with its pontoons all the way around it. Between the porpoise and the adjacent seal pool is a gangway, under which is located the underwater tunnel. (Photo credit: Héloïse Hamel)

cleared. A protective wall was added to the plans, which would eventually form the outside of the harbour porpoise enclosure. The first director of Fjord&Bælt (F&B), Andreas Brogaard Buhl, who was employed already in the planning phase and represented the owners in the supervisory committee for all the site constructions, consulted with hydrologists at the Danish Technical University and oceanographer Carsten Jürgensen at the regional county. No experts would give any written guarantee for the bold building plans, so the director needed to take a calculated risk.

Early in the planning, the chief curator of the local museums, Erland Porsmose, had come up with the idea of F&B keeping harbour porpoises (*Phocoena phocoena*; hereafter “porpoises”), small cetacean residents to inner Danish waters. The idea was not so far-fetched for Erland, being a son of a fisherman and from youth well acquainted with porpoises from the Belts. Erland asked Søren Andersen for help. Søren had decades of experience keeping porpoises at Danish research facilities (see Søren’s down-memory essay [Anderson, 2009], as well as the video interview and podcast on the *Aquatic Mammals* website). However, Søren thought it would be difficult to keep the porpoises alive for extended time periods. From his experience, porpoises acquired many different types of diseases that could be fatal when kept over longer periods. Erland, who remembered Søren’s facility from the 1960s, where his father sometimes had

delivered porpoises, was hoping that a larger pen with direct access to natural seawater would help keep the porpoises in good health.

The dream of having porpoises at F&B remained and was strongly supported by Andreas Brogaard Buhl, the director. One important requisite for obtaining a permit to keep porpoises was to carry out relevant research on the animals. Lee Miller and Annemarie Surlykke at SDU, as well as Bertel Møhl at Aarhus University, supplied support letters, indicating how useful the center could become for research projects. Through zealous footwork and with help from experts, a permit for keeping animals was granted from the Danish Environmental Protection Agency. Geneviève Desportes, a local whale scientist, was employed at F&B as porpoise expert. Together with Andreas and the Swedish marine mammal expert Mats Amundin (with long-term experience from Søren Andersen’s projects), she developed F&B’s porpoise plans in all its practical details (nets, pontoon systems, medical pen, and husbandry program).

An ambitious construction plan evolved to secure sufficient space for keeping porpoises and to use the tidal exchange in the harbour to secure continuous renewal of the water. While retaining a large section of the original harbour wall, two openings were created to allow for continuous in and out flow of the water. Double netting across those openings was established along and inside the original harbour wall, creating a 30 ×

20 m and 3 to 5 m deep net pen. The proposed solution was accepted as it involved less expenditures for the contractor and had the advantage of keeping a navigational marker in its original position. The construction work was carried out by Monberg&Thorsen A/S, with engineering help from Birch and Krogboe A/S (nowadays part of the consultant company NIRAS A/S). It was not easy to design the sea pen and make it sustainable and functional for its purposes. Kerteminde harbour is well known for hefty changes in water level, leading to strong currents and fast changes in visibility conditions. When the current is outward going and wind blows into the harbour from the east, standing wave patterns in the harbour challenge any structures and boats adjacent to the harbour walls. During cold winters, the harbour could freeze, but thanks to the strong water movements, this has only been a serious challenge on rare occasions. Along the pen's perimeter were pontoons that moved up and down with the daily changes in water level; this was where animal care staff would feed and train the porpoises. A special challenge was a small floating "medical" pool that could be moved around and fixed at different positions in the sea pen.

Whereas seals could be found in many zoological gardens, porpoises would give the center its *uniqueness*. F&B's original and current logo both contain a porpoise. It was important both to plan for research and for outreach activities. When planning the center, there was great concern about the high bycatch rate of porpoises in gillnets.

Reducing bycatch to sustainable levels became a major aim of the research. Outreach activities around the porpoises should inform the public about the challenges of nature conservation in Danish waters and create awareness and awe for local fauna. Among the early visitors to the center, many had no idea that porpoises could be found in Danish waters.

Sabrina Brando, F&B's first animal caretaker and trainer, joined the team in early 1997 and helped finalize indoor/outdoor pools, equipment, and husbandry programs in preparation for the arrival of the animals. Sabrina had previous experience with training and rehabilitating stranded porpoises at Dolfinarium Harderwijk in the Netherlands. She had also helped in research projects on porpoises led by Ron Kastelein and described in a seminal book by Read et al. (1997). In March 1997, the center opened its doors for the public.

A Flying Start: Eigil and Freja

On 7 April 1997, less than a month after F&B's official opening, two porpoises (later named "Eigil" and "Freja") were brought to Kerteminde from a pound net near Korsør in the Great Belt. Geneviève Desportes was on board the boat transporting the animals. The porpoises were first held in small quarantine pools inside the Marine Biological Research Center (MRC), next door to F&B, to monitor their health condition. When the porpoises arrived at the center, they were not used to eating



Early work with the porpoises: (a) Marianne Rasmussen feeding the newly arrived Eigil and Freja in the inside quarantine pool, spring 1997; and (b) Geneviève Desportes and Sabrina Brando feeding the porpoises once they were moved outside to the porpoise enclosure, spring or summer 1997. (Photo source: F&B/SDU)

dead fish, whether served whole or in pieces. A variety of techniques were used to try to get them to eat. Following a suggestion from Søren Andersen, the trainer used a fishing pole with a dead fish on a line, shaking it to make it appear alive. The animals' behaviour was closely observed, and their breathing rate counted several times day and night to monitor their well-being. Veterinarian Ursula Siebert, with expertise in marine mammals, visited regularly to do health assessments on the animals.

The animals eventually learned to accept dead fish from the trainer's hand. The porpoises stopped when taking the fish and thereby got more familiar with the trainer. After some weeks, and after a health check, the porpoises were moved outdoors into a floating pen inside the main pen. Fish intake, various health parameters, progress in training, and behavioural observations were recorded. These observations are still logged 25 years later and used both for husbandry purposes and scientific studies. The animals got used to being handled in the smaller pool, and they learned to swim in and out of the pool into the larger pen. Bringing the animals into the smaller pool, including accepting that the gate was closed, allowed for full monthly health checks.

Already from the very start, biology students from SDU were hired to help with animal husbandry. Marianne Rasmussen and Jakob Højer Kristensen were among the first ones to be hired and assist in the work with the porpoises, supervised by Sabrina Brando.

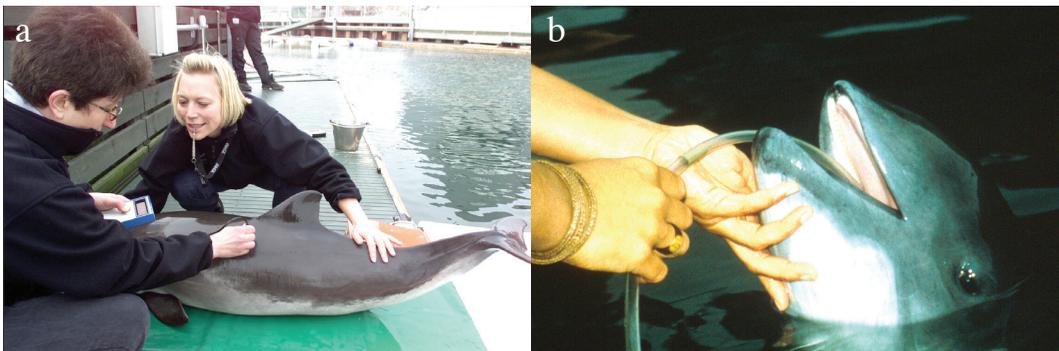
Since the 1950s, there has been increased experience gained in housing and training dolphins as well as porpoises. Behaviorism was in its hey day, and operant conditioning with positive reinforcement became the general rule for training animals both for public presentations and research. Training the animals also augmented potentially invasive health inspections, which was made

possible within the framework of an animal care management program. Experiences were also used from Søren's and Sabrina's earlier experiences training porpoises. Further assistance in husbandry, science, and health monitoring came from Mats Amundin, Christina Lockyer, and Ursula Siebert. In early 1998, Kirstin Anderson Hansen was hired as a second trainer, arriving from the Shedd Aquarium in Chicago with a large portfolio of training work.

The animals rapidly learned how to station in front of the care staff and how to present their bodies to the trainers for body checks. A small sloping platform was installed, and the animals were trained to swim onto the platform for visual inspection, regular weighing, and for other voluntary husbandry behaviours. While the porpoises were out of the water, the audience had a greater chance to see their entire bodies.

Mats Amundin suggested that an audio and video link could be run across the road to the house where Sabrina was living. This would make it possible for her to listen to the porpoises not only during the day but also at night. Unfortunately, implementation of this idea was at the time too challenging. Today, trainers have direct access to surveillance cameras, and an online acoustic monitoring system from the porpoise enclosure is on its way.

Initially, there was some local resistance to having foreigners work with the porpoises as F&B had been intended to create new jobs for locals. The director met up with the local union to explain why it was necessary to hire foreigners for some of the positions. At that time, no one in the local fishing port (or in the entire country of Denmark for that matter) had relevant experience in animal training and marine mammal care and science. Now, 25 years later, the F&B training staff not only consists of foreigners but, to a large extent, of Danes as well.



Collecting biologically relevant data with participating animals: (a) Geneviève Desportes and Kirstin Anderson Hansen measuring blubber thickness; and (b) an animal trained to have a tube inserted all the way down into its stomach. This tube can either be used to administer water or medicine to sick animals. (Photo source: F&B)

Husbandry and Research

Over time, the animal care and training programs expanded. The animals were trained to voluntarily participate in health care, including sampling from the blowhole and stomach; blood collection; and measuring length, blubber thickness, girths, and weight. The medical sampling provided invaluable information on porpoise biology, including growth and sexual maturity, making it possible to follow individual growth in relation to food type and quantity, and also seasonal changes in body condition (Desportes et al., 2003; Lockyer et al., 2003). Christina Lockyer and Ursula Siebert supplied tetracycline antibiotics to the animals' diet at specific intervals to time-mark the growth layers observed in their teeth. Thus, they could determine the precise deposition rate of the growth layers and more precisely determine animal age. From aging studies using their teeth, we know that porpoises can live beyond 20 years of age, even though most individuals die before reaching sexual maturity at 3 to 5 years old.

Eigil and Freja were also trained to wear suction cups and eye cups, expanding the possibilities for research projects regarding sonar and behavior (Atem et al., 2009; DeRuiter et al., 2009; Verfuß et al., 2009; Wisniewska et al., 2012). They could be blindfolded when solving echolocation tasks and wear various types of measurement equipment during research sessions to obtain information on sound production, body acceleration, heart rate, and hearing (Beedholm & Miller, 2007; Lucke et al., 2009; Madsen et al., 2010; Linnenschmidt et al., 2012; Wisniewska et al., 2015; Elmegaard et al., 2016; Smith et al., 2021).

The animal training programs at F&B had a long-term influence on improved animal welfare programs—not just in Danish zoos but also internationally. Work done at F&B provided the first publication showing that animal training reduces stress (Desportes et al., 2007). Prior to F&B, Danish zoos had little experience in animal training and how it could be used to improve health care and welfare. The experience of the animal care and training staff was used to develop an animal behaviour and training course, which has been running yearly at MRC and F&B since 2007. It is also held at European zoos at regular intervals.

One of the first large European Union-funded research projects at F&B was called EPIC (Elimination of Harbour Porpoise Incidental Catches), which ran from 1998 until 2000. The project was coordinated by Christina Lockyer at the Danish Institute for Fisheries Research and involved Geneviève Desportes (F&B) and Mats Amundin (Kolmården Wildlife Park and Linköping University, Sweden), as well as Paul Lepper and

the late David Goodson (both at Loughborough University, UK). Together with Ph.D. student Jonas Teilmann and post doc Jakob Tougaard (both at SDU) and trainers Sabrina Brando and Kirstin Anderson Hansen, they investigated how the F&B porpoises reacted to so-called pinger sounds, intended to be used in gillnet fisheries to reduce bycatch (Teilmann et al., 2006).

The sound source was placed in one end of the pen. The locations of the animals' surfacings were recorded from a balcony on the laboratory building facing the porpoise pen as an indicator of their evasive response. A heart rate logger was also used to determine responses to sounds. The experiments were carried out at night, partly because this is the natural time for porpoise foraging and partly because the reflections from the sky could be avoided, allowing underwater behaviours to be observed using spotlights. Both animals were marked with a bright white zinc cream on their backs to make them easier to distinguish. It was clear that the porpoises surfaced farther away when exposed to the pinger sounds compared to the pre-sound period, and that they immediately returned to baseline behaviour when the sound was switched off. The best pinger sound to startle the porpoises were noise pulses in the porpoises' best hearing range (Teilmann et al., 2006). These promising findings were later successfully confirmed in commercial fishing operations and used to develop a commercial and much used pinger called Aquamark 100 through which eight different EPIC signals were transmitted in semi-random order to avoid habituation.

Another important aspect of the EPIC project was to study how foraging behaviour may affect the risk of being entangled in nets. A "fish toilette" was designed to flush live fish from the pontoon through a hose to be ejected between some rocks placed in front of one of the underwater windows in the tunnel. The released fish quickly hid among the rocks and triggered so-called "bottom grubbing," a head-down foraging style in which the porpoises used very high click repetition rates to search for the fish with their sonar, every so often forcing water out of their mouths to displace fish from the rocks. When engaged in bottom grubbing, the porpoises advanced in a vertical body orientation with their sonar aimed into the rocks under limited light conditions, with their attention focused on hunting small fish. It is unlikely that animals engaged in bottom grubbing, a behaviour subsequently also observed in wild animals, would detect bottom-set gillnets. Therefore, bottom-grubbing animals may risk entanglement in fishing gear.

The EPIC project also included tests of a so-called "interactive" pinger. This pinger is silent until detecting the sonar clicks from an

approaching porpoise, delaying habituation and reducing noise pollution. After completion of the EPIC project, Geneviève and Mats tested interactive pingers on wild porpoises in a nearby nature protected area. The site has a high vantage point from where the porpoises' responses to experimental interactive pingers could be measured using a theodolite. An archival click detector was integrated into the pinger to record the sonar clicks preceding and eventually triggering the deterrent sounds. Having nearby sites where wild porpoises could frequently and easily be observed turned out to be a valuable addition to F&B research, where findings made on trained animals could be verified or supported. Nowadays, a large portion of our research activities target wild animals.

Another early research project at F&B and MRC, investigated by Ph.D. student Ursula Verfuß and supervised by Lee Miller at SDU and Hans-Ulrich Schnitzler at the University of Tübingen, Germany, focused on how harbour porpoises captured their prey. Just as during the EPIC project, the trainers were intimately involved in Ursula's experiments. She deployed an array of hydrophones at one end of the pool. The trainer sent the porpoise from the other side of the pool at the same time that a live fish was thrown into the water in front of the array. There were underwater video cameras, as well as an in-air camera above the catch area, that filmed the behaviour of the porpoises catching the fish. Sounds were recorded on high-speed tape recorders, and details of the porpoises' foraging behaviour were documented. Some trials were made with the fish in front of a metal net to see how unwanted "clutter" echoes affected their ability to catch fish. The porpoises performed surprisingly well under these conditions.

Porpoises use narrowband, high-frequency pulsed clicks for echolocation. The clicks center around 130 kHz and are emitted in trains with increasing click rate while approaching the fish. During the final catch sequence, hundreds of clicks are emitted every second. Besides being described in Ursula's Ph.D. thesis, these studies resulted in two publications that detailed the biosonar behaviour of porpoises (Verfuß et al., 2005, 2010).

Life and Death in Porpoises

In April 1999, an additional porpoise was brought to F&B after being caught in a pound net in Baaring Vig, Denmark. She was named "Nuka." After a short quarantine period, Nuka was put in the floating pen and, after further adaptation, to the large semi-open sea pen. She was a healthy, well-nourished porpoise and a quick learner. Unfortunately, she died in February 2000 after 10 days of illness. The necropsy revealed that she had suffered from a

rare bacterial infection, which caused a large gathering of pus in the wall of her heart.

Another young female, called "Sif," was collected from a pound net in July 2004 at Fjellerup Strand, Jutland. Even though she had recurrent health problems during her entire life and was often under long-term treatments for various ailments, she participated in a wide range of hearing and echolocation studies. As an adult, Sif bonded closely with Freja but rarely with Eigil, leaving us to believe that females are more social whereas males stick more to themselves. In our current animal collection, where we also have two females (one of which is still Freja) and one male, this view is challenged by Freja socializing more with the male than with the female. Sif died in December 2017 from a multitude of complications.

A facility keeping animals during extended periods of time will experience animals dying, but hopefully also animals being born. Already during their first years in the facility, we observed Freja and Eigil involved in mating behaviours. Surprisingly, in 2006, Freja had her first calf, which, unfortunately, did not survive the birth. A few months later, Freja was pregnant again. We detected the second pregnancy at an early stage and developed detailed plans for monitoring Freja throughout the pregnancy to be able to do whatever was needed for her to have a successful birth, but also to obtain data interesting for research. Since very few facilities had ever had a pregnant porpoise, we based our monitoring on information from bottlenose dolphins (*Tursiops truncatus*; e.g., Sweeney et al., 2010), the most common species held in human care. We recorded Freja's weight, food intake, girth, inter-mammary distance, and body temperature throughout her pregnancy. The last two measurements allowed us to precisely pinpoint the delivery date. Approaching delivery, Freja's body temperature dropped by almost 2°C, and her inter-mammary distance increased from 5 to 8 cm. We built a "baby crib" based on our experience from the previous year. This inner pen was made of top padded aluminum frames with small mesh size netting to prevent the calf from getting entangled in the net. The net frames were arranged in such a way that the calf could not be stuck underneath the pontoons. A careful desensitization program was implemented to get Freja used to the new pen and to being separated from her social group.

After months of waiting, Freja gave birth to "Frigg" on 8 August 2007 at 0200 h, following nine long hours of labor. During the delivery, we recorded the frequency of the flexions and contractions and all the behavioural changes during this never-before observed event. The entire process was continuously filmed from the balcony on the laboratory building facing the porpoise pen.

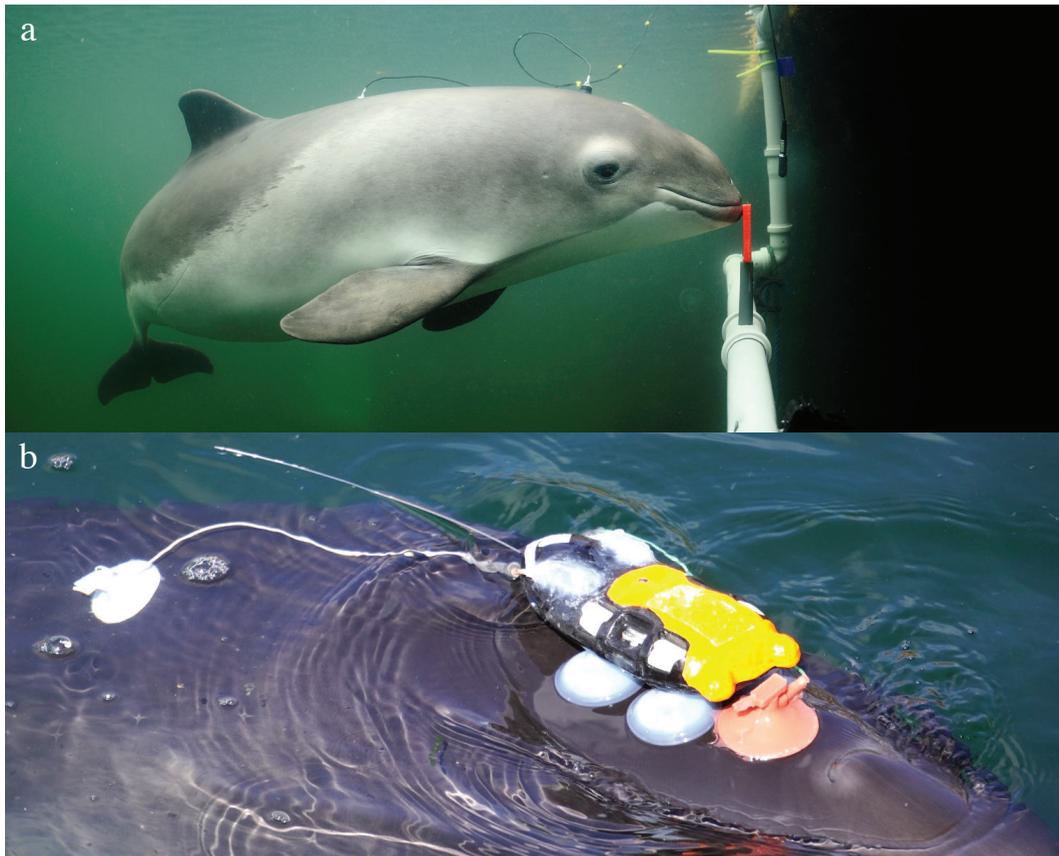
This was the first successful porpoise birth ever. Frigg rapidly developed into a fast learner and very social animal, without the natural deep-rooted hesitation that can be found in wild animals brought into zoological facilities. We had the opportunity to study her behavioural, physical, and sensory development, and the bonds between her and her mother Freja throughout the first year of her life. Using a hydrophone array, we could show that Frigg, already at day 4, apparently had a functional sonar (Delgado, 2016). Sadly, Frigg died in 2013 from a parasitic infection of *Toxoplasmosis*.

In 2013 and 2014, Sif delivered two male calves that only survived a few days after birth. It is still not entirely clear what went wrong in these cases. The first calf, named “Mr X,” did not seem to develop normal porpoise calf behaviour but would swim almost mindlessly along the perimeter of the pool, being indifferent to Sif’s efforts in calling for his attention. The second calf, named “Mr. Y,”

never attended to Sif but instead seemed to adopt the perimeter of the pool as his mother. Both calves were euthanized within a week after birth when we had to conclude that the relationship to the mother did not develop as needed. This was one of the hardest decisions ever made by F&B staff.

After the unsuccessful births of Sif’s two calves, we realized that the future of having porpoises at F&B could not rely on births. Instead, we started to plan for collecting new animals from pound nets. This is a rather complicated operation, involving many people, permits, and interactions with fishermen and more. In May 2017, all logistical requirements had been fulfilled, and a suitable animal, named “Idun,” was collected from a pound net in the Great Bælt. Regretfully, Idun did not survive the first period of quarantine.

A new attempt was made in September 2020. Two female porpoises were caught in a pound net



Research training of porpoises: (a) The porpoise Eigil at his listening station. When sounds are played back to him, we can tap into the response of his brain through two electrodes kept in place with suction cups; and (b) Freja wearing a Dtag, which was equipped with additional suction cups to record the heart rate and auditory brainstem response in a freely swimming animal. (Photo source: F&B/SDU)

at Korsør in the Great Belt. They were estimated to be about 15 months old. One of the porpoises was extremely malnourished and suffering from deep wounds, probably bites from a seal that had been observed inside the pound net. Both females, given the names “Vilja” and “Saga,” were placed in a quarantine facility for acclimation and while waiting for blood test results. After three days, both animals began eating hand-held fish. Basic training, such as station training and target recognition, was started. Vilja, the smaller and injured animal, unfortunately died after 14 days of intensive care and rehabilitation. Necropsy results showed that she had a very high load of parasites, causing bleeding lesions and damage to her lungs and other organs.

Saga, however, was in good health and was soon moved out of quarantine into the smaller medical pool in the main sea pen where Freja was kept, allowing Saga and Freja to have acoustic and visual contact with each other. Since Saga was now in a larger and deeper pool than when she was in quarantine, it was possible to give her more advanced training and have more stimulus control during training. This was necessary before Saga could be released into the main pool with access to Freja. After a few weeks, and when her training was more solid, we let her swim out to meet Freja. They greeted one another by “grooming,” swimming side-by-side gently touching each other with their dorsal fins and flippers. Grooming is commonly seen both in captive and wild animals.

A little more than a month later, in early November 2020, a local fisherman arrived at F&B with a young male porpoise and a dead calf. Both had been caught in his pound net in Kerteminde Bay, just outside F&B. From its length, the male porpoise was determined to have been born in 2019. A routine full health check was performed, and he was then placed in the quarantine facility. He was given the name “Eskild.” The caretakers had learned a lot from taking care of Saga and Vilja, so Eskild started eating from a trainer’s hand two days after arrival. Once his blood and health tests were satisfactory, Eskild was moved to the small outdoor floating pen, which allowed for auditory and visual contact with Saga and Freja. After a couple of weeks, he was released into the main pen, where he has remained with Saga and Freja ever since.

Education and Collaboration

Already from the start, education was a large part of keeping the porpoises for research. Lee Miller started a university whale biology course in 1996 for which students went to visit the Kolmården dolphinarium in Sweden, hosted by

Mats Amundin. For all classes after F&B opened, there has always been a traditional stay at F&B to learn about the animals. The course had a practical component which included the students learning how to record sound from the harbour porpoises using hydrophones and filming the porpoises to study their behaviour. The course is still running at SDU every spring. With 20 to 25 participants every year, both from Denmark and abroad, approximately 500 students have completed the class.

Since 1996, SDU has arranged an international graduate student class in acoustic communication of animals every second or third year that takes place in August. Initiated by Axel Michelsen, founder of SDU’s Department of Biology, this class has attracted some of the most prominent bioacousticians as teachers, as well as a wealth of students. Part of the class is taught at MRC and involves practical work with the F&B porpoises.

From the very start, F&B developed close ties with experienced scientists and animal trainers in the zoo community, and with organizations and institutions working in marine mammal science, training, and outreach. These ties have been fundamental for the long-term survival of the center and are continually evolving. In 2008, an effort to strengthen the working relationship between F&B’s trainers and marine mammal scientists was initiated to increase the mutual understanding of each other’s work processes. Several initiatives were put into action: study trips to renowned research facilities, a research training course, research training seminars, and the enrollment of biology students in the animal departments’ internship program.

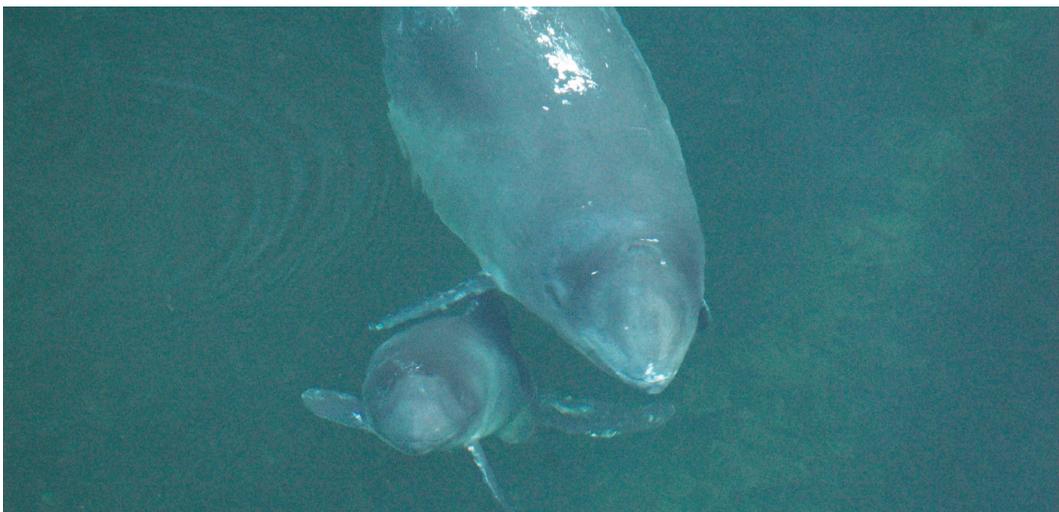
The effort was, in part, inspired by work conducted at the Pinniped Cognition and Sensory Systems Lab at Long Marine Laboratory in Santa Cruz, California, where biology students were allowed to train the animals used in their research projects. Before being allowed to do so, the students worked extensively with the animals under supervision of the training staff to gain a deeper understanding of operant conditioning principles and the crucial husbandry training. Some of F&B’s trainers spent time at the Pinniped Lab, working with Colleen Reichmuth and her team, to observe and learn from the dynamics between researcher/trainer and animal, and to get a grip on training methodologies and to bring home ideas of how to implement similar activities at F&B.

In that same year, 2008, F&B and SDU hosted a research training course funded by the Nordic Marine Academy. Trainers and students from all over the world spent two weeks learning from some of the world’s foremost experts in aquatic animal

training and research. Teachers included, among others, Ken Ramirez, Shedd Aquarium, author of the “bible,” *Animal Training: Successful Animal Management Through Positive Reinforcement*; Marlee Breese and Paul Nachtigall, University of Hawaii; Colleen Reichmuth, Long Marine Lab at the University of California at Santa Cruz; and Richard Fay, Parmly Hearing Institute at Loyola University—all well-known for their scientific work. Wolf Hanke, Rostock University; Kirstin Anderson Hansen, Odense Zoo (at that time); and Sabrina Brando, AnimalConcepts, also participated. Part of the course consisted of practical training with gerbils that were taught different behaviors throughout the course. We continue to work with several of these teachers and students from this training course to this day.



Ultrasonic scanner picture of a cross section of a calf inside the womb of Freja in 2008 (Photo source: F&B)



Freja with her calf Frigg (Photo source: F&B)

Animal Rights Criticism

One day in 1997, activists from Greenpeace Germany arrived at the newly conceived center to demonstrate against F&B keeping whales in captivity. This was before the era of social media, and Greenpeace’s objective was to publish a feature article about the protests in their membership magazine. In response to the activists, the center director decided to invite them inside so that they could see and hear for themselves what took place at the center. The openness paid off. A few weeks later, Greenpeace published an article about how F&B would benefit wild porpoises.

Today, 25 years later, the challenges are similar. You regularly hear strong opinions against keeping marine mammals in captivity, often expressed without background knowledge on how the work inside facilities such as F&B is carried out and what the objectives are. Social media and “fake news” have only made the polarization greater. Despite outside pressures, F&B has maintained an attitude of transparency, which may also have been a key for convincing many people about the benefits associated with the center’s activities.

In the first decades of the center’s lifetime, protesters only sent a few letters to the center every now and then. In the 2010s, demonstrations started to be organized during the international *Empty the Tanks* day in May, but the event never attracted more than a few tens of demonstrators. Even though we could see the national and international climate against having marine mammals in captivity was growing, F&B was barely affected by this trend. We thought that by having a strong focus on research and education,

and being a nonprofit organization, it would help us to make opponents understand that we were not keeping animals in captivity for entertainment and economic gain.

When F&B acquired new porpoises in 2020, several large animal rights NGOs launched large protest campaigns against the center. The Danish office of the British-based World Animal Protection was leading the campaign, but soon other international organizations, such as Sea Shepherd as well as Danish NGOs (e.g., Læsø-based *Vilde hvaler*), joined the campaign. For many months, the center was under constant accusations and threats to its buildings and animals.

We care about good animal welfare and seriously consider the ethical dimension of having wild animals in a facility for outreach and research. Unfortunately, the nature of these campaigns is not representative of the actual situation at F&B and the conditions of our animals, such as claims that the porpoises are showing behavioral signs of maltreatment. The campaigns reported the incorrect species kept, that no relevant research is done, and that experiments with the animals damaged them physically. These claims were posted on different internet sites, including the official site for the Danish Animal Ethics Committee who, after we contacted them, retracted this from their site. F&B and its associates spent months explaining and disclaiming false accusations, but apart from some substantial standpoints that were interesting to debate, there was an apparent reluctance by the opposers to change claims in the face of facts. Even to date, many false claims remain.

A common standpoint in these discussions is that we should not earn money from keeping animals in captivity, in spite of the fact that F&B is a nonprofit organization with all revenues going back to the daily maintenance and care of the animals. By involving the public in our work, we ensure that they can see how we care for the animals and directly witness how the animals are doing. Also, the public learns both about the biology of porpoises and other whales, and about their place in the marine ecological food webs. The public also learns to connect our scientific work with other conservation efforts. The entrance fees make our work possible: keeping animals in human care is expensive and would be very difficult without the contributions from visitors.

Another common remark is that it is only ethically acceptable to study animals in the field instead of using captive animals. We would argue that the possible negative ethical consequences of some of our research at F&B is smaller on our porpoises kept under controlled conditions. They

are accustomed to being handled and are desensitized to being exposed to a wide variety of acoustic signals or procedures used in our scientific experiments. The recently developed portable heart rate tags, attached by suction cups, are now a reliable tool to study how animals in the wild get stressed by, for example, boat noise. If the technical development and testing of such devices would have all been done on wild porpoises, many animals would have to have been caught and stressed by wearing earlier versions of the device. To perform such development on animals kept under controlled conditions that are used to being handled by trainers is sounder from both ethical and research perspectives.

The animal rights campaigns today are mainly organized on social media. We usually respond by posting accurate corrections on factual mistakes in the campaigns as well as our standpoints on the actual issues. We have also published statements in local newspapers and on popular science platforms (see www.fjord-baelte.dk for details). We have participated in and arranged several debates that have been broadcast on social media and on national TV, stating our views and those of World Animal Protection. We also provided the opportunity for people to write in and ask us questions.

Anyone working with research and animals should be prepared to have their work questioned and scrutinized. Last year's campaigns have strengthened our own way of thinking about our work and have motivated us to think differently on how to organize and present our work in the future.

Who Pays the Bills?

The major funding for building F&B was made available through a grant from Arbejdsmarkedets Feriefond (a Danish foundation administering the citizens' fund money) and Kerteminde Municipality. The municipality continues to give generous yearly financial support to the center's activities. Originally, the agreement between the exhibition center and the researchers was that the exhibition center would pay for keeping the harbour porpoises, including a marine mammal expert and trainers. Scientists wanting to study the animals contribute economically to the costs of husbandry through research grants.

The research on F&B porpoises has been funded through several EU research programs focusing on how to avoid bycatch in gillnets using acoustic pingers and other methods. The Danish Environmental Protection Agency is providing funding on a yearly basis, focusing on mitigating bycatch as well as understanding other negative impacts from human activities

on porpoises. The German Federal Ministry of Environment and the German Environmental Protection Agency have also supported several projects, mainly focusing on the effects of intense underwater sounds on the hearing abilities of porpoises. Funds were also received from the U.S. Office of Naval Research, a source still supporting the center today. The Swedish Navy has also been involved in projects at the center. For basic research, the research department also receives funds from Danish foundations, such as the Danish National Research Council, as well as private foundations, such as Carlsberg Foundation, Oticon Foundation, and Villum. Recently, Human Frontiers funded a 3-year project about the cognitive abilities of porpoises. Outreach activities on marine mammals have been funded through EU Horizon 2020.

A small center like F&B is always vulnerable to economic downswings. During the past decades, a major task for the director has therefore been to find funding for extending the center's premises. In 2022, the current director, Mette Thybo, was successful in obtaining a large grant from AP Møller for a major extension of the center. The new center will be almost double in size and thereby have a much higher degree of stability.

Impact

More than 100 scientific papers and book chapters have been produced from F&B research out of which more than 60 publications contain data from the F&B porpoises (see supplemental material for this HP on the *Aquatic Mammals* website). Work done on the effects of intense human-made sound sources on hearing has influenced legislation in Germany and Denmark as well as international guidelines on noise pollution. Many of the center's activities have been awarded prizes for best oral and poster presentations at international conferences. Several of the close collaborators at the center have won prestigious awards: Ursula Siebert received the Humboldt Award, Peter Madsen (Aarhus University) was awarded the Danish Eliteforskerpris, and Magnus Wahlberg won (together with colleagues) the ASCOBANS outreach prize.

The national and international media coverage has always been extensive. F&B research and outreach activities have been covered in all major Danish written and broadcasted media. Internationally, the center has been featured in *Der Spiegel*, *Bild der Wissenschaften*, *American Scientist*, and *National Geographic*, and in several TV documentaries (e.g., BBC, NDR, and ZDF).



Freja, the oldest harbour porpoise on record, jumping for a ball during the 25th year anniversary of Fjord&Bælt in April 2022 (Photo credit: H eloise Hamel)

Outlook

Quite often, we hear people asking themselves, or us, “Soon you must know all there is to know about porpoises!” In fact, the situation is quite the opposite. Even after 25 years of studies, we are merely scratching the surface in understanding the lives of harbour porpoises. Regarding porpoise biology, we learned that the animals fatten seasonally in response to declining sea temperature and perhaps daylight changes in winter, thus increasing their energy deposits and insulation (Lockyer et al., 2003). In addition, we have learned that teeth growth layers can be used to assess animal age. Even though animals may rarely attain more than 20 years of age, most porpoises do not live beyond five years in the wild, right around the time of sexual maturity (Kesselring et al., 2017). The challenges that porpoises encountered when F&B opened 25 years ago have only increased. Porpoises are vulnerable to ongoing development of new types of human disturbances. Fishing methods are changing but still result in significant bycatch of porpoises (Larsen et al., 2021). The clearing of World War 1 and World War 2 underwater explosive devices is still ongoing and can be lethal for porpoises (Siebert et al., 2022). Common types of pollution are still prevalent in the food webs, which may make animals more prone to diseases as well as lowering reproductivity (Siebert et al., 2020). These are among the handful of problems that still need our attention and research efforts. Even though many of these issues can be studied using animals in the wild, it remains important to keep porpoises at F&B to have direct access to animals for more controlled studies.

Note: Supplemental material for this Historical Perspectives essay is available in the “Supplemental Material” section of the *Aquatic Mammals* website (https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147), and a Historical Perspectives video interview with Magnus Wahlberg is available in the “Historical Perspectives” section (https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=11&Itemid=146).

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Literature Cited

- Andersen, S. (2009). Investigations on harbor porpoise (*Phocoena phocoena*) in Denmark from 1962 to 1983. *Aquatic Mammals*, 35(3), 394-398. <https://doi.org/10.1578/AM.35.3.2009.394>
- Atem, A. C. G., Rasmussen, M. H., Wahlberg, M., Petersen, H. C., & Miller, L. A. (2009). Changes in click source levels with distance to targets: Studies of free-ranging white-beaked dolphins (*Lagenorhynchus albirostris*) and captive harbor porpoises (*Phocoena phocoena*). *Bioacoustics*, 19(1), 49-65. <https://doi.org/10.1080/09524622.2009.9753614>
- Beedholm, K., & Miller, L. A. (2007). Automatic gain control in harbor porpoises (*Phocoena phocoena*)? Central versus peripheral mechanisms. *Aquatic Mammals*, 33(1), 69-75. <https://doi.org/10.1578/AM.33.1.2007.69>
- Delgado, L. (2016). *Acoustic development and behavior in odontocete calves* (Ph.D. thesis). University of Southern Denmark, Kerteminde.
- DeRuiter, S., Bahr, A., Blanchet, M-A., Hansen, S. F., Kristensen, J. H., Madsen, P. T., Tyack, P. L., & Wahlberg, M. (2009). Acoustic behaviour of echolocating porpoises during prey capture. *Journal of Experimental Biology*, 212, 3100-3107. <https://doi.org/10.1242/jeb.030825>
- Desportes, G., Buholzer, L., Anderson-Hansen, K., Blanchet, M-A., Acquarone, M., Shephard, G., Brando, S., Vossen, A., & Siebert, U. (2007). Decrease stress; train your animals: The effect of handling methods on cortisol levels in harbour porpoises (*Phocoena phocoena*) under human care. *Aquatic Mammals*, 33(3), 286-292. <https://doi.org/10.1578/AM.33.3.2007.286>
- Desportes, G., Kristensen, J. H., Benham, D., Wilson, S., Jepsen, T., Korsgaard, B., Siebert, U., Driver, J., Amundin, M., Hansen, K., & Shephard, G. (2003). Multiple insights into the reproductive function of harbour porpoises (*Phocoena phocoena*): An ongoing study. *NAMMCO Scientific Publications*, 5, 91-105. <https://doi.org/10.7557/3.2741>
- Elmegaard, S. L., Johnson, M., Madsen, P. T., & McDonald, B. I. (2016). Cognitive control of heart rate in diving harbor porpoises. *Current Biology*, 26(22), R1175-R1176. <https://doi.org/10.1016/j.cub.2016.10.020>
- Kesselring, T., Viquerat, S., Brehm, R., & Siebert, U. (2017). Coming of age: Do female harbour porpoises (*Phocoena phocoena*) from the North Sea and Baltic Sea have sufficient time to reproduce in a human influenced environment? *PLOS ONE*, 12, e0186951. <https://doi.org/10.1371/journal.pone.0186951>

- Larsen, F., Kindt-Larsen, L., Kirk Sørensen, T., & Glemarec, G. (2022). *Bycatch of marine mammals and seabirds: Occurrence and mitigation* (DTU Aqua Report No 389-2021). Technical University of Denmark.
- Linnenschmidt, M., Klopper, L. K., Wahlberg, M., & Nachtigall, P. E. (2012). Stereotypical rapid source level regulation in the harbour porpoise biosonar. *Naturwissenschaften*, 99(9), 767-771. <https://doi.org/10.1007/s00114-012-0948-7>
- Lockyer, C., Desportes, G., Hansen, K., Labberté, S., & Siebert, U. (2003). Monitoring growth and energy utilization of the harbour porpoise (*Phocoena phocoena*) in human care. *NAMMCO Scientific Publications*, 5, 107-120. <https://doi.org/10.7557/3.2743>
- Lucke, K., Siebert, U., Lepper, P. A., & Blanchet, M-A. (2009). Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. *The Journal of the Acoustical Society of America*, 125(6), 4060-4070. <https://doi.org/10.1121/1.3117443>
- Madsen, P. T., Wisniewska, D. M., & Beedholm, K. (2010). Single source sound production and dynamic beam formation in echolocating harbour porpoises (*Phocoena phocoena*). *Journal of Experimental Biology*, 213, 3105-3110. <https://doi.org/10.1242/jeb.044420>
- Read, A., Wiepkema, J., & Nachtigall, P. E. (1997). *The biology of the harbour porpoise*. De Spil Publishers.
- Siebert, U., Blanchet, M-A., Teilmann, J., Anderson Hansen, K., Kristensen, J., Bunskoek, P., Dietz, R., Desforges, J-P., Sonne, C., & Desportes, G. (2020). Haematology and clinical blood chemistry in harbour porpoises (*Phocoena phocoena*) from the inner Danish waters. *Environmental International*, 143, 105937. <https://doi.org/10.1016/j.envint.2020.105937>
- Siebert, U., Stürznickel, J., Schaffeld, T., Oheim, R., Rolvien, T., Prenger-Berninghoff, E., Wohlsein, P., Lakemeyer, J., Rohner, S., Schick, L. A., Gross, S., Nachtsheim, D., Ewers, C., Becher, F., Amling, M., & Morell, M. (2022). Blast injury on harbour porpoises (*Phocoena phocoena*) from the Baltic Sea after explosions of deposits of World War II ammunition. *Environmental International*, 159, 107014. <https://doi.org/10.1016/j.envint.2021.107014>
- Smith, A. B., Madsen, P. T., Johnson, M., Tyack, P., & Wahlberg, M. (2021). Toothed whale auditory brainstem responses measured with a non-invasive, on-animal tag. *JASA Express Letters*, 1(9), 091201. <https://doi.org/10.1121/10.0006454>
- Sweeney, J. C., Stone, R., Campbell, M., McBain, J., St. Leger, J., Xitco, M., Jensen, E., & Ridgway, S. (2010). Comparative survivability of *Tursiops* neonates from three U.S. institutions for the decades 1990-1999 and 2000-2009. *Aquatic Mammals*, 36(3), 248-261. <https://doi.org/10.1578/AM.36.3.2010.248>
- Teilmann, J., Tougaard, J., Miller, L. A., Kirketerp, T., Hansen, K., & Brando, S. (2006). Reactions of captive harbor porpoises (*Phocoena phocoena*) to pinger-like sounds. *Marine Mammal Science*, 22(2), 240-260. <https://doi.org/10.1111/j.1748-7692.2006.00031.x>
- Verfuß, U. K., Miller, L. A., & Schnitzler, H-U. (2005). Spatial orientation in echolocating harbour porpoises (*Phocoena phocoena*). *Journal of Experimental Biology*, 208, 3385-3394. <https://doi.org/10.1242/jeb.01786>
- Verfuß, U. K., Miller, L. A., Pilz, P. K. D., & Schnitzler, H-U. (2009). Echolocation by two foraging harbour porpoises (*Phocoena phocoena*). *Journal of Experimental Biology*, 212, 823-834. <https://doi.org/10.1242/jeb.022137>
- Wisniewska, D. M., Johnson, M., Beedholm, K., Wahlberg, M., & Madsen, P. T. (2012). Acoustic gaze adjustments follow attention during active target selection in echolocating porpoises. *Journal of Experimental Biology*, 215, 4358-4373. <https://doi.org/10.1242/jeb.074013>
- Wisniewska, D. M., Ratcliffe, J. M., Beedholm, K., Christensen, C. B., Johnson, M., Koblitz, J. C., Wahlberg, M., & Madsen, P. T. (2015). Range-dependent flexibility in the acoustic field of view of echolocating porpoises (*Phocoena phocoena*). *eLife*, 4, e05651. <https://doi.org/10.7554/eLife.05651>