18 November 2009

Mr. P. Michael Payne, Chief
Permits, Conservation, and Education Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway, Room 13635
Silver Spring, MD 20910

Dear Mr. Payne:

The Marine Mammal Commission, in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the application submitted by Eglin Air Force Base under section 101(a)(5)(D) of the Marine Mammal Protection Act. The Commission also has reviewed the National Marine Fisheries Service's 19 October 2009 *Federal Register* notice (74 Fed. Reg. 53474) requesting comments on the application and proposing to issue the authorization, subject to certain conditions.

The applicant is requesting a renewal, with no changes, of its one-year incidental harassment authorization for air-to-surface gunnery tests and training activities within the Eglin Gulf Test and Training Range in the Gulf of Mexico. The applicant's current incidental harassment authorization expires on 10 December 2009. The proposed activities could involve the taking by harassment of small numbers of up to 16 species of cetaceans incidental to surface impacts of projectiles and small underwater detonations (up to approximately 5 lbs). A typical mission, using an AC-130 gunship aircraft, lasts approximately five hours without refueling and six hours when air-to-air refueling is required. The live-fire phase of the mission can last from 30 to 90 minutes but is typically completed in 30 minutes. The proposed activities would typically be conducted at least 15 miles from the coast.

RECOMMENDATIONS

The Marine Mammal Commission recommends that the National Marine Fisheries Service issue the requested authorization, provided that the Service—

- revise its interpretation of temporary threshold shift (TTS) to indicate that it constitutes a temporary loss of function with consequences that may vary widely from negligible to biologically significant (e.g., compromised ability to forage, respond to reproductive cues, detect predators) depending on a variety of circumstances at the time the loss occurs, including the nature of the structural and functional hearing loss, the animal's behavioral response to the stimulus, its history, and environmental conditions; as such, and under certain circumstances, TTS may constitute Level A harassment;
- conduct a thorough review of the considerable information available on behavioral responses of marine mammals to sound before it moves forward with proposed regulations tied to the narrow findings of Schlundt et al. (2000) as the basis for estimating the number of animals likely to exhibit behavioral responses;

- require performance testing of mitigation measures to assess their actual effectiveness at detecting marine mammals. The Navy is being asked to conduct similar evaluation programs, and doing so seems essential if our collective approach to such matters is to be considered science-based;
- work with the Air Force to design and conduct the necessary performance verification testing for electronic detection devices under the pertinent sea state conditions; and
- review its overall strategy for managing risks associated with such testing and training activities and consider how its existing strategy might be modified to be both more precautionary but also more likely to lead to scientific advancement in this field of research.

RATIONALE

The Commission commented on the Air Force's previous application concerning activities at Eglin by letter of 29 June 2007 (enclosed and incorporated here by reference). The Service issued that authorization (see 22 December 2008 *Federal Register* notice, enclosed), and, in doing so, disagreed with certain of the Commission's comments and recommendations (see Comment/Responses 5 through 10 in the *Federal Register* notice of issuance). The primary point of contention pertains to the potential biological significance of a temporary threshold shift (TTS) in hearing and, especially, the ability of a marine mammal with TTS to function in its environment. As detailed below, the Commission continues to stand by its previous comments and recommendations and again recommends that they be adopted by the Service.

Definition of TTS

TTS is a consequence of physical or physiological changes in the hearing apparatus. The hearing impairment may compromise an affected animal's ability to forage, respond to reproductive cues, detect predators, or carry out other important behaviors. Because such loss of function may have important secondary consequences, the Commission continues to question the Service's conviction that TTS, in all instances, constitutes no more than Level B harassment.

Indeed, the Commission believes that the phenomenon of TTS is too complex to support such a definitive finding. That complexity arises, at least in part, from physiological, behavioral, and environmental covariates. The available information on TTS in marine mammals is limited, and to a degree, scientists must depend on observations or studies with other mammals, including humans to draw their conclusions. The evidence suggests that TTS may occur as part of a process where a physicochemical system is stressed by a strong stimulus. As the stimulus approaches the system's tolerance, the system may undergo a variety of chemical and physical changes. When the stimulus is relatively close to the tolerance, the system may respond in ways that could be considered adaptive, in the same manner that a muscle strengthens when subjected to strong exercise. However, as the stimulus becomes stronger, it will exceed the system's physiological tolerance, initiating changes that compromise function—in this case a reduction in hearing sensitivity within a certain frequency range. Clearly, a subject with TTS is not completely deafened, but its hearing has been compromised

to a degree and, therefore, it is partially deafened, albeit only for a period of time. The seriousness of this loss will depend on, among other things, the extent and duration of the loss, the frequencies involved, and the implications of the loss with regard to the animal's ability to carry out vital functions. Undoubtedly, some—and the Commission would venture to guess most—losses will be of negligible consequence. But others could be more serious: TTS is not an all-or-nothing phenomenon but rather one better characterized as a multi-dimensional continuum. The consequences also vary depending on the number of times that the animal is subjected to such a stimulus. If other mammals serve as useful models for marine mammals, then some exposure could lead to a degree of adaptation, but continued or repeated exposure also can lead to a permanent threshold shift (PTS), as has been clearly demonstrated in humans (e.g., occupational hearing loss). So the phenomenon of TTS and its physical and physiological consequences are not simple matters that are easy to predict in an open-and-closed manner. Indeed, TTS and its consequences remain a topic of investigation in humans, even after hundreds of studies involving tens of thousands of subjects. In contrast, only small numbers of marine mammals have been involved in studies of TTS where much remains to be learned.

The situation is further complicated by the fact that exposure to sounds that produce TTS, or to sounds of considerably less intensity or energy, may result in behavioral responses to the sound. Marine mammals that live at the extremes of their physiological tolerance are particularly vulnerable if such sounds cause the animals to change their behavior in ways that exceed that tolerance. Deep-diving beaked whales, for example, may not be affected directly by sonar pulses, but if they alter their diving patterns significantly, they could suffer harm physiologically. Similarly, animals under stress for other reasons (e.g., poor condition, disease) may be more likely to strand when exposed to additional risk factors, including noise. Certainly behaviorists can describe a wide range of considerations that affect how a marine mammal will respond to a sound—such things as the animal's age, sex, condition, reproductive state, and recent experiences with similar risk factors (i.e., similar sounds). Anything that would impede a marine mammal from responding in a normal manner to an acoustic stimulus could have an adverse impact on mother-calf relations, reproduction, foraging, and an animal's ability to detect a predator or a warning of danger. To argue the contrary is to suggest that such considerations are irrelevant during the period in which the animal's hearing is compromised. The Commission believes that ignoring such considerations is neither biologically nor ecologically reasonable. The challenge, which will take some time to overcome, is to determine how often such stimuli result in serious consequences.

In other contexts, the Service seems to agree with the Commission. For example, in its 7 July 2006 *Federal Register* Notice of Issuance regarding the Navy's Rim of the Pacific Antisubmarine Warfare Exercises within the Hawaiian Islands Operating Area (71 Fed. Reg. 38716), the agency states that—

> TTS consists of temporary, short-term impacts to auditory tissue that alter physiological function, but that are fully recoverable without the requirement for tissue replacement or regeneration. An animal that experiences a temporary

> reduction in hearing sensitivity suffers no permanent injury to its auditory system, but, *for an initial time post-exposure, may not perceive some sounds due to the reduction in sensitivity. As a result, the animal may not respond to sounds that would normally produce a behavioral reaction (such as a predator or the social calls of conspecifics, which play important roles in mother-calf relations, reproduction, foraging, and warning of danger)* [emphasis added]. This lack of response qualifies as a temporary disruption of normal behavioral patterns - the animal is impeded from responding in a normal manner to an acoustic stimulus.

More recently, in the 20 October 2009 proposed rule to authorize training and research activities by the Department of Defense in the Mariana Islands Range Complex (74 Fed. Reg. 53796), the Service recognized that—

> TTS can disrupt behavioral patterns by inhibiting an animal's ability to communicate with conspecifics and interpret other environmental cues important for predator avoidance and prey capture. However, depending on the degree (elevation of threshold in dB), duration (i.e., recovery time), and frequency range of TTS, and the context in which it is experienced, TTS can have effects on marine mammals ranging from discountable to serious…. [A] larger amount and longer duration of TTS sustained during a time when communication is critical for successful mother/calf interactions could have more serious impacts if it were in the same frequency band as the necessary vocalizations and of a severity that it impeded communication.

In view of the complexity of this issue and the limitations in scientific data for marine mammals, the Commission does not believe that hard-and-fast rules about the effects or significance of TTS are justified. If the Service refuses to recognize the complex nature of such occurrences, it may slow or undermine scientific progress toward a better understanding of marine mammal vulnerability to sound. For all these reasons, the Marine Mammal Commission recommends that the National Marine Fisheries Service revise its interpretation of TTS to indicate that it constitutes a temporary loss of function with consequences that may vary widely from negligible to biologically significant (e.g., compromised ability to forage, respond to reproductive cues, detect predators) depending on a variety of circumstances at the time the loss occurs, including the nature of the structural and functional hearing loss, the animal's behavioral response to the stimulus, its history, and environmental conditions; as such, and under certain circumstances, TTS may constitute Level A harassment.

Potential Takes by Behavioral Harassment

As the Commission noted in its letter regarding the Air Force's previous application for activities within the Eglin Gulf Test and Training Range, the Service appears to assume that nine of ten animals that are exposed to sounds loud enough to result in TTS would not otherwise be disturbed. The Commission finds such an assumption is contradicted by extensive observations of marine mammal responses to noise in a wide range of settings. In its previous letter the Commission

recommended that the Service either provide further justification for this assumption or revise its estimates of the number of animals likely to be taken by behavioral disturbance to a more realistic number.

The Service responded that it currently uses dual criteria (i.e., based on energy and pressure) for calculating Level B harassment by TTS but uses only a pressure criterion for calculating behavioral harassment. The Service stated that, because of a lack of empirical information and data, dual criteria for assessing Level B harassment by behavioral changes alone cannot be developed. The Service noted that, for the proposed gunnery exercises, which involve multiple detonations and potential marine mammal exposures, it has calculated estimates for behavioral responses by marine mammals at levels lower than those causing TTS—as opposed to activities involving only single detonations (e.g., the Navy's shock trials) where, the Service believes, it is unlikely that marine mammals would have significant behavioral responses but could incur TTS. The Service states that in experiments with bottlenose dolphins and beluga whales, Schlundt et al. (2000) determined that the lowest sound pressure levels, over all frequencies, at which altered behaviors in the animals were observed ranged from 178 to 193 dB re 1 μPa for bottlenose dolphins and from 180 to 196 dB re 1 μPa for beluga whales. The Service therefore believes that it is reasonable to consider that sub-TTS (behavioral) effects occur at approximately 6 dB below the TTS-inducing sound level, or at approximately 176 dB in the greatest 1/3 octave band energy flux density level/sound exposure level. The Service stated that it plans to investigate this issue during the development of a rule on the proposed action and will provide the Commission and the public additional information at that time.

Here again, the Commission questions the Service's reasoning on at least three grounds. First, it is simply unreasonable to assume that any single pressure threshold can serve as an indicator of whether a marine mammal will exhibit a significant behavioral response to a particular noise in its environment. Although the significance of behavioral responses can be difficult to determine, volumes of scientific information indicate that marine mammals respond in potentially significant or meaningful ways to a range of sound levels well below those that might produce TTS. Perhaps the first strong indication that the introduction of sound in the marine environment could be a problem arose from observations that bowhead and beluga whales respond behaviorally to sounds produced miles away. One of the main elements of the Navy's research program to investigate the effects of low frequency sounds produced by SURTASS LFA sonar indicated that gray whales altered their migration path when exposed to sounds of much lower levels than those expected to cause TTS. Indeed, in that program the Navy was reluctant to raise sound levels above 150 dB. And the Service itself has directed extensive efforts to use acoustic harassment devices to alter the behavior of marine mammals (i.e., keep them away from fishing nets or aquaculture pens). The effect of Navy sonar (onboard the USS *Shoup*) on a pod of killer whales in Puget Sound clearly indicated that noise can cause erratic behavior at levels well below those that cause TTS. And certain species, such as the harbor porpoise, are known to be highly sensitive to noise-related disturbance even when the noise intensity is orders of magnitude less than that expected to cause TTS. In short, scientists and managers have gathered ample evidence that sound can cause substantial behavioral effects at levels

well below that expected to cause TTS. Here, too, the challenge is to study and understand the consequences of such changes in behavior.

Second, in the face of all this additional information documenting behavioral responses at much lower sound intensities, the heavy reliance on observations from Schlundt et al. (2000) by the Service is unjustified. Those authors described changes in behavior for animals that were in an artificial situation, had been used for experimentation, and were limited by their surroundings in the kinds of behavior they could exhibit (e.g., they could not leave their enclosures). When they did show behavioral changes, those changes indicated the possibility of more severe effects (e.g., apparent disorientation) than might be attributed simply to a change in behavior. Furthermore, Schlundt et al. themselves recognized that the behavior of animals in their captive setting was not necessarily indicative of the behavior of animals in the wild. Indeed, they wrote that they were defining

> a behavioral alteration as a deviation from an animal's trained behaviors as a result of exposure to intense sound. This is in contrast to field observations, where the reaction of naïve animals to novel stimuli is often difficult to interpret; a behavioral reaction in these circumstances may occur at levels corresponding to the animal's detection of the sound, rather than a level which may produce TTS (Green et al. 1994).

Third, as described above, the response of a wild marine mammal is a function not only of the stimulus but also the animal itself, its experiences, and its environment. To assume otherwise is to ignore a wealth of information about marine mammal responses to sound.

Again, the more difficult challenge here is not to determine whether sound at relatively low levels can produce behavioral responses but rather to determine when those changes become significant to the animals involved or the stocks to which they belong. With that in mind, the Marine Mammal Commission recommends that the National Marine Fisheries Service conduct a thorough review of the considerable information available on behavioral responses of marine mammals to sound before it moves forward with proposed regulations tied to the narrow findings of Schlundt et al. (2000) as the basis for estimating the number of animals likely to exhibit behavioral responses.

Potential Lethal Takes

In its letter regarding the Air Force's previous application seeking authorization for the taking of marine mammals incidental to activities at Eglin, the Commission recommended that the Service review and provide more reasonable justifications for its models and assumptions that led to the conclusion that no animals would be killed during the course of a full year of such operations. The Service responded, among other things, that the assumptions made by the Air Force in developing its direct physical impact calculations can be found in the 2002 Final Programmatic Environmental Assessment for Eglin under the analysis of Alternative 1. The Service then cited a

range of calculations by the Air Force that indicate that the chance of a marine mammal being killed is indeed low.

However, in its letter on the previous application, the Commission noted that, according to the Service, up to 25 animals may be within the zone of impact (22.1 m/72.5 ft) from an aircraft flying at 6,000 ft (1,829 m), but that none would be killed. The Commission noted that it was hard to imagine that, either through inaccuracy in firing or confusion of or responses by marine mammals near the impact site (e.g., darting into the zone of impact), no animals could be killed over the course of a year of such exercises. The Service responded that the Commission's concern fails to account for the effectiveness of the mitigation measures required under the incidental harassment authorization and the fact that, because the usual areas for conducting live-fire events are in coastal waters, there is a high likelihood that marine mammals will be detected electronically by aircraft personnel when at the firing altitude. The Service also indicated that, if marine mammals have been seriously injured or killed by A-S gunnery exercises in the past, necropsies of marine mammals stranded in the area should have single or multiple wounds caused by gunnery projectiles. The Service states that it is unaware of any marine mammals containing the projectiles with a caliber consistent with that used in exercises at Eglin.

Such debates could continue indefinitely, but doing so would not necessarily lead to informed science-based conclusions or ensure protection of marine mammals. As is necessary in similar situations involving military exercises, the Commission believes it is not sufficient simply to contend that mitigation measures are or are not effective. Such disagreements are best resolved by performance testing and validation of mitigation measures using scientific methods. If such verification procedures or performance tests have indeed been conducted, then the results should be described. If the Air Force has the ability to detect marine mammals at the surface with "high likelihood," then it would be useful to describe how it does so if such descriptions would not require disclosure of classified information. Although the Service indicates that most of the animals at risk are coastal and therefore more easily detected, the application indicates that activities typically will be conducted at least 15 miles from shore. It is not clear to the Commission why these animals will be more easily detected. With regard to evidence based on necropsies of stranded animals, the question to address is whether stranded animals recovered along the beach can be used reliably to identify the causes of death for animals that occur at least 15 miles from shore. This is a sampling problem that prompts questions about relying too heavily on conclusions drawn solely from examining stranded dead animals. Although the lack of observations of marine mammals with evidence of wounds from training and testing exercises is encouraging, it is not a sufficient basis to conclude with full confidence that no animals are being killed. With these concerns in mind, the Marine Mammal Commission recommends that the National Marine Fisheries Service require performance testing of mitigation measures to assess their actual effectiveness at detecting marine mammals. The Navy is being asked to conduct similar evaluation programs, and doing so seems essential if our collective approach to such matters is to be considered science-based.

Revision of Sea State Restrictions

In commenting on the previous application, the Commission also recommended that the Service require the applicant to provide additional information to support its request to raise restrictions from sea state 3 to sea state 4. The application indicates that the gunship sensor suite "provides the best daytime/nighttime performance in normal weather/sea conditions at this altitude [6,000 feet] range." However, the application does not define what constitutes "normal weather/sea conditions" in the test area and does not describe the performance of the sensor suite in sea state 4. The application also indicates that the Air Force expects to be able to observe marine mammal species effectively in weather conditions that allow observation of the gunnery target flare. However, the applicant does not provide any data to support such an inference.

The Service responded that, because the Air Force relies principally on electronic detection instrumentation and less on visual observations, an increase in sea state from 3 to 4 is unlikely to compromise mitigation effectiveness or result in the probability of increased harassment, injury, or mortality of marine mammals. Although this may be the case, the Commission believes that empirical data are needed to support the claim that electronic detection rates are sufficiently high under conditions above sea state 3 before the Air Force and Service conclude such efficacy. Until such data are available and demonstrate the effectiveness of electronic detection techniques in higher sea states, authorizing incidental taking during operations conducted in such conditions is premature. Therefore, the Marine Mammal Commission recommends that the National Marine Fisheries Service work with the Air Force to design and conduct the necessary performance verification testing for electronic detection devices under the pertinent sea state conditions.

Finally, the uncertainty regarding many of the matters discussed above calls for a precautionary approach to both research and management. Although scientists are able to characterize human-related sounds in the ocean, they still have considerable work to do to characterize the significance of those sounds to marine mammals and other marine life. This seems to be a highly appropriate time to use a precautionary approach, that is, using science as the tool for gaining a better understanding but imposing a degree of caution in management consistent with the remaining uncertainty. Further, the burden for addressing that uncertainty should fall first on the action agency for it is its activities that pose potential risks. As the regulatory agency, however, the Service also bears responsibility for making sure that the essential research is conducted so that, over time, the uncertainty can be reduced and all involved agencies have better confidence that they understand and are managing well the risks associated with the kinds of activities proposed in the subject application. With that in mind, the Marine Mammal Commission recommends that the National Marine Fisheries Service review its overall strategy for managing risks associated with such testing and training activities and consider how its existing strategy might be modified to be both more precautionary but also more likely to lead to scientific advancement in this field of research.

Please contact me if you have any questions concerning these comments and recommendations.

Sincerely,

Timothy J. Ragen, Ph.D.
Executive Director

Enclosures

References

Green, D.M., H.A. DeFerrari, D. McFadden, J.S. Pearce, A.N. Popper, W.J. Richardson, and P.L. Tyack. 1994. Low-frequency sound and marine mammals: Current knowledge and research needs. National Academy, Washington, D.C.

Schlundt, C.E., J.J. Finneran, D.E. Carder, and S.H. Ridgway. 2000. Temporary shift in masked hearing thresholds of bottlenose dolphins, *Tursiops truncatus*, and white whales (*Delphinapterus leucas*) after exposure to intense tones.