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# Assessment of Management to Mitigate Anthropogenic Effects on Large Whales

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Ballenas mayores; enmarañamiento; evaluación de esfuerzos de manejo/mitigación; impacto con embarcaciones

**Abstract:** *United States and Canadian governments have responded to legal requirements to reduce human-*

*induced whale mortality via vessel strikes and entanglement in fishing gear by implementing a suite of regulatory actions. We analyzed the spatial and temporal patterns of mortality of large whales in the Northwest Atlantic (23.5°N to 48.0°N), 1970 through 2009, in the context of management changes. We used a multinomial logistic model fitted by maximum likelihood to detect trends in cause-specific mortalities with time. We compared the number of human-caused mortalities with U.S. federally established levels of potential biological removal (i.e., species-specific sustainable human-caused mortality). From 1970 through 2009, 1762 mortalities (all known) and serious injuries (likely fatal) involved 8 species of large whales. We determined cause of death for 43% of all mortalities; of those, 67% (502) resulted from human interactions. Entanglement in fishing gear was the primary cause of death across all species (n= 323), followed by natural causes (n= 248) and vessel strikes (n= 171). Established sustainable levels of mortality were consistently exceeded in 2 species by up to 650%. Probabilities of entanglement and vessel-strike mortality increased significantly from 1990 through 2009. There was no significant change in the local intensity of all or vessel-strike mortalities before and after 2003, the year after which numerous mitigation efforts were enacted. So far, regulatory efforts have not reduced the lethal effects of human activities to large whales on a population-range basis, although we do not exclude the possibility of success of targeted measures for specific local habitats that were not within the resolution of our analyses. It is unclear how shortfalls in management design or compliance relate to our findings. Analyses such as the one we conducted are crucial in critically evaluating wildlife-management decisions. The results of these analyses can provide managers with direction for modifying regulated measures and can be applied globally to mortality-driven conservation issues.*

**Resumen:** *Los gobiernos de Estados Unidos y Canadá han respondido a requerimientos legales para reducir la mortalidad de ballenas inducida por humanos por medio de impacto con embarcaciones y enmarañamiento en artes de pesca mediante la implementación de un conjunto de acciones reguladoras. Analizamos los patrones espaciales y temporales de la mortalidad de ballenas mayores en el Atlántico Noroccidental (23.5°N a 48.0°N), de 1970 a 2009, en el contexto de cambios de manejo. Utilizamos un modelo logístico multinomial ajustado por la máxima probabilidad de detección de tendencias en mortalidades por causa específica en el tiempo. Comparamos el número de muertes provocadas por humanos con los niveles de remoción biológica potencial (i.e., mortalidad específica provocada por humanos sustentable). De 1970 a 2009, hubo 1762 muertes (conocidas) y lesiones serias (casi fatales) involucrando 8 especies de ballenas mayores. Determinamos la causa de 43% de todas las muertes; de ellas, 67% (502) resultaron de interacciones humanas. El enmarañamiento en artes de pesca fue la causa principal de muerte en todas las especies (n= 323), seguida de causas naturales (n= 248) e impacto de embarcaciones (n= 171). Los niveles sustentables de mortalidad establecidos fueron excedidos consistentemente hasta en 650% en 2 especies. Las probabilidades de muerte por enmarañamiento y por impacto de embarcaciones incrementaron significativamente de 1990 a 2009. No hubo cambio significativo en la intensidad local de mortalidad por todas las causas o por impacto de embarcaciones antes y después de 2003, año en el que se implementaron numerosos esfuerzos de mitigación. Hasta ahora, los esfuerzos regulatorios no han reducido los efectos letales de las actividades humanas sobre las ballenas a nivel de población, aunque no excluimos la posibilidad de éxito de medidas enfocadas a hábitats locales específicos que no estuvieron dentro de la resolución de nuestro análisis. No es claro como se relacionan con nuestros resultados las deficiencias en el diseño o implementación del manejo. Análisis como el que realizamos son*

*cruciales para la evaluación crítica de decisiones para el manejo de vida silvestre, y los resultados de estos análisis pueden proporcionar directrices a los manejadores para que modifiquen medidas regulatorias y puedan ser aplicadas globalmente en temas de conservación relacionadas con mortalidad.*

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