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LITERATURE CITED

- AINLEY, D. G. 1977. Feeding methods in seabirds: a comparison of polar and tropical communities in the eastern Pacific Ocean. Pp. 669-685 in G. A. Llano (editor). Adaptations within Antarctic ecosystems. Gulf Publishing Company, Houston, TX.
- AINLEY, D. G., AND R. J. BOEKELHEIDE. 1983. An ecological comparison of seabird communities in the South Pacific Ocean. *Studies in Avian Biology* 8:2-23.
- AINLEY, D. G., AND R. J. BOEKELHEIDE. 1990. Seabirds of the Farallon Islands: ecology, dynamics, and structure of an upwelling-system community. Stanford University Press, Palo Alto, CA.
- AINLEY, D. G., W. R. FRASER, W. O. SMITH, T. L. HOPKINS, AND J. J. TORRES. 1991. The structure of upper level pelagic food webs in the Antarctic: effect of phytoplankton distribution. *Journal of Marine Systems* 2:111-122.
- AINLEY, D. G., E. F. O'CONNOR, AND R. J. BOEKELHEIDE. 1984. The ecology of seabirds in the Ross Sea, Antarctica. *American Ornithologists' Union Monograph* 32:1-97.
- AINLEY, D. G., C. A. RIBIC, AND W. R. FRASER. 1992. Does prey preference affect habitat choice in Antarctic seabirds? *Marine Ecology Progress Series* 90:207-221.
- AINLEY, D. G., C. A. RIBIC, AND W. R. FRASER. 1994. Ecological structure among migrant and resident seabirds of the Scotia-Weddell Confluence region. *Journal of Animal Ecology* 63:347-364.
- AINLEY, D. G., C. A. RIBIC, AND L. B. SPEAR. 1993. Species-habitat relationships among Antarctic seabirds: a function of physical and biological factors? *Condor* 95:806-816.
- ALVERSON, F. 1961. Daylight occurrence of myctophid fishes off the coast of Central America. *Pacific Science* 15:483.
- ASHMOLE, N. P. 1971. Sea bird ecology and the marine environment. Pp. 223-286 in D. S. Farner, and J. R. King (editors). *Avian biology*. Volume I. Academic Press, New York, NY.
- ASHMOLE, N. P., AND M. J. ASHMOLE. 1967. Comparative feeding ecology of seabirds of a tropical ocean island. *Peabody Museum of Natural History Yale University, Bulletin* 24:1-131.
- AU, D. W. K., AND R. L. PITMAN. 1986. Seabird interactions with dolphins and tuna in the eastern Tropical Pacific. *Condor* 88:304-317.
- AUGUSTIN, N. H., D. L. BORCHERS, E. D. CLARKE, AND S. T. BUCKLAND. 1998. Spatio-temporal modelling for the annual egg production method of stock assessment using generalized additive models. *Canadian Journal of Fisheries and Aquatic Sciences* 55:2608-2621.
- AUSTER, P. J., C. A. GRISWOLD, M. J. YOUNGBLUTH, AND T. G. BAILEY. 1992. Aggregations of myctophid fishes with other pelagic fauna. *Environmental Biology of Fishes* 35:133-139.
- BALLANCE, L. T. 1993. Community ecology and flight energetics in tropical seabirds of the eastern Pacific: energetic correlates and guild structure. Ph.D. dissertation, University of California, Los Angeles, CA.
- BALLANCE, L. T., AND R. L. PITMAN. 1999. Feeding ecology of tropical seabirds. Pp. 2057-2071 in N. Adams, and R. Slotow (editors). *Bird*

- life of South Africa. Proceedings of the 22nd International Ornithological Congress, Durban. Natural History Book Service, Johannesburg, Republic of South Africa.
- BALLANCE, L. T., R. L. PITMAN, AND S. B. REILLY. 1997. Seabird community structure along a productivity gradient: importance of competition and energetic constraint. *Ecology* 78:1502–1518
- BALTZ, D. M., AND G. V. MOREJOHN. 1977. Food habitats and niche overlap of seabirds wintering on Monterey Bay, California. *Auk* 94: 526–543.
- BANG, B. G. 1966. The olfactory apparatus of tube-nosed birds (Procellariiformes). *Acta Anatomica* 65:391–415.
- BELOPOL'SKII, L. O. 1957. Ecology of sea colony birds of the Barents Sea. (Translation 1961, Israel Program for Scientific Translations) Academic Science, Karelian Branch, USSR.
- BERTRAND, A., F.-X. BARD, AND E. JOSSE. 2002. Tuna food habits related to the microneckton distribution in French Polynesia. *Marine Biology* 140:1023–1037.
- BORCHERS, D. L., S. T. BUCKLAND, I. G. PRIEDE, AND S. AHMADI. 1997. Improving the precision of the daily egg production method using generalized additive models. *Canadian Journal of Fisheries and Aquatic Sciences* 54:2727–2742.
- BRIED, J. 2005. Diving ability of the Maderian Storm-Petrel. *Waterbirds* 28:162–166.
- BRIGGS, K. T., AND E. W. CHU. 1987. Trophic relationships and food requirements of California seabirds: updating models on trophic impact. Pp. 279–304 in J. P. Croxall (editor). *Seabirds: feeding ecology and role in marine ecosystems*. Cambridge University Press, London, UK.
- BRILL, R. W., B. A. BLOCK, C. H. BOGGS, K. A. BIGELOW, E. V. FREUND, AND D. J. MARCINEK. 1999. Horizontal movements and depth distribution of large adult yellowfin tuna (*Thunnus albacares*) near the Hawaiian Islands, recorded using ultrasonic telemetry: implications for the physiological ecology of pelagic fishes. *Marine Biology* 133:395–408
- BROOKE, M. DE L. 2004. *Albatross and petrels across the World*. Oxford University Press, New York, NY.
- BROOKE, M. DE L., AND G. ROWE. 1996. Behavioural and molecular evidence for specific status of light and dark morphs of the Herald Petrel *Pterodroma heraldica*. *Ibis* 138:420–432.
- BROWN, R. G. B. 1980. Seabirds as marine animals. Pp. 1–39, in J. Burger, B. L. Olla, and H. E. Winn (editors). *Behavior of marine animals*. Plenum Press, New York, NY.
- BUCKLEY, T. T., AND B. S. MILLER. 1994. Feeding habitats of yellowfin tuna with fish aggregation devices in American Samoa. *Bulletin of Marine Science* 55:445–459.
- CATARD, A., AND H. WEIMERSKIRCH. 1999. Satellite tracking of White-chinned Petrel and comparison with other Procellariiformes. Pp. 3008–3023 in N. J. Adams, and R. H. Slotow (editors). *Bird life of South Africa*. Proceedings of the 22nd International Ornithological Congress, Durban. Natural History Book Service, Johannesburg, Republic of South Africa.
- CATARD, A., H. WEIMERSKIRCH, AND Y. CHEREL. 2000. Exploitation of distant Antarctic waters and close shelf-break waters by White-chinned Petrels rearing chicks. *Marine Ecology Progress Series* 194:249–261.
- CHASTEL, O. AND J. BRIED. 1996. Diving ability of Blue Petrels and Thin-billed Prions. *Condor* 98:627–629.
- CLARKE, E. D., L. B. SPEAR, M. L. MCCracken, F. F. C. MARQUES, D. L. BORCHERS, S. T. BUCKLAND, AND D. G. AINLEY. 2003. Validating the use of generalized additive models and at-sea surveys to estimate size and temporal trends of seabird populations. *Journal of Applied Ecology* 40:278–292
- CLARKE, M. R. 1966. A review of the systematics and ecology of oceanic squids. *Advances in Marine Biology*, Volume 4. Academic Press, London, UK.
- CLARKE, M. R. 1986. A handbook for the identification of cephalopod beaks. Clarendon Press, Oxford, UK.
- CLARKE, M. R., J. P. CROXALL, AND P. A. PRINCE. 1981. Cephalopod remains in regurgitations of the Wandering Albatross *Diomedea exulans* L. at South Georgia. *British Antarctic Survey Bulletin* 54:9–21.
- CLARKE, T. A. 1978. Diel feeding patterns of 16 species of mesopelagic fishes from Hawaiian waters. *Fishery Bulletin* 76:495–513.
- COX, S. P., T. E. ESSINGTON, J. K. KITCHELL, S. J. D. MARTELL, C. J. WALTERS, C. BOGGS, AND I. KAPLAN. 2002. Reconstructing ecosystem dynamics in the central Pacific Ocean, 1952–1998. II. A preliminary assessment of the trophic impacts of fishing and effects on tuna dynamics. *Canadian Journal of Fisheries and Aquatic Sciences* 59: 1736–1747.
- CROXALL, J. P., AND P. A. PRINCE. 1980. Food, feeding ecology and ecological segregation of seabirds at South Georgia. *Biological Journal of the Linnean Society* 14:103–131.
- CROXALL, J. P., AND P. A. PRINCE. 1994. Dead or alive, night or day: how do albatrosses catch squid? *Antarctic Science* 6:155–162.

- CRUZ, J. B., C. LALAS, J. B. JOLLETT, J. C. KITSON, P. O'B. LYVER, M. IMBER, J. E. NEWMAN, AND H. MOLLER. 2001. Prey spectrum of breeding Sooty Shearwaters (*Puffinus griseus*) in New Zealand. *New Zealand Journal of Marine and Freshwater Research* 35:817-829.
- DIAMOND, A. W. 1983. Feeding overlap in some tropical and temperate seabird communities. *Studies in Avian Biology* 8:24-46.
- DUFFY, D. C., AND S. JACKSON. 1986. Diet studies of seabirds: a review of methods. *Colonial Waterbirds* 9:1-17.
- DUFFY, D. C., AND L. B. LAURENSEN. 1983. Pellets of Cape Cormorants as indicators of diet. *Condor* 85:305-307.
- EASTMAN, J. T. 2004. Antarctic fish biology: evolution in a unique environment. Academic Press, San Diego.
- ESSINGTON, T. E., D. E. SCHINDLER, R. J. OLSON, F. F. KITCHELL, C. BOGGS, AND R. HILBORN. 2002. Alternative fisheries and the predation rate of yellowfin tuna in the eastern Pacific Ocean. *Ecological Applications* 12:724-734.
- FIEDLER, P. C. 2002. Environmental change in the eastern tropical Pacific Ocean: review of ENSO and decadal variability. *Marine Ecology Progress Series* 244:265-283.
- FLINT, E. N., AND K. A. NAGY. 1984. Flight energetics of free-living Sooty Terns. *Auk* 101:288-294.
- FURNESS, B. L., R. C. LAUGKSCH, AND D. C. DUFFY. 1984. Cephalopod beaks and studies of seabird diets. *Auk* 101:619-620.
- FURNESS, R. W., AND R. T. BARRETT. 1985. The food requirements and ecological relationships of a seabird community in north Norway. *Ornis Scandinavica* 16:305-313.
- FURNESS, R. W., AND C. M. TODD. 1984. Diets and feeding of Northern Fulmars *Fulmarus glacialis* during the breeding season: a comparison between St. Kilda and Shetland colonies. *Ibis* 126:379-387.
- GJOSAETER, J., AND K. KAWAGUCHI. 1980. A review of the world resources of mesopelagic fish. UN Food and Agriculture Organization, Fisheries Technical Papers 193:1-51. Rome, Italy.
- GOULD, P. J. 1967. Nocturnal feeding of *Sterna fuscata* and *Puffinus pacificus*. *Condor* 69:529.
- HAMPTON, J., J. R. SIBERT, P. KLEIBER, M. N. MAUNDER, AND S. J. HARLEY. 2005. Decline of Pacific tuna populations exaggerated? *Nature* 434:E1-E2.
- HARRISON, C. S., T. S. HILDA, AND M. P. SEKI. 1983. Hawaiian seabird feeding ecology. *Wildlife Monographs* 85. Wildlife Society, Bethesda, MD.
- HARRISON, C. S., AND M. P. SEKI. 1987. Tropic relationships of tropical seabirds at the Hawaiian Islands. Pp. 301-326 in J. P. Croxall (editor). *Seabirds: feeding ecology and role in marine ecosystems*. Cambridge University Press, London, UK.
- HARRISON, P. 1983. *Seabirds: An identification guide*. Houghton Mifflin Co., Boston, MA.
- HARTMANN, A. R., AND T. A. CLARKE. 1975. The distribution of myctophid fishes across the central equatorial Pacific. *Fishery Bulletin* 73:633-641.
- HASTIE, T., AND R. TIBSHIRANI. 1990. *Generalized additive models*. Chapman and Hall, London, UK.
- HINKE, J. T., I. C. KAPLAN, K. AYDIN, G. M. WALTERS, R. J. OLSON, AND J. F. KITCHELL. 2004. Visualizing the food-web effects of fishing for tunas in the Pacific Ocean. *Ecology and Society* 9(1):10. <<http://www.ecologyandsociety.org/vol9/iss1/art10>> (22 February 2007).
- HOPKINS, T. L., D. G. AINLEY, J. J. TORRES, AND T. M. LANDCRAFT. 1993. Trophic structure in open waters of the marginal ice zone in the Scotia-Weddell confluence region during spring (1983). *Polar Biology* 13:389-397.
- HUIN, N. 1994. Diving depths of White-Chinned Petrels. *Condor* 96:1111-1113.
- HUNT, G. L., JR. 1988. The distribution of seabirds at sea: physical and biological aspects of their marine environment. Pp. 167-171 in *Current Topics in Avian Biology*. Proceedings of the International 100, EO-G Meeting, Bonn, Germany.
- HUNT, G. L., JR. 1990. The pelagic distribution of marine birds in a heterogeneous environment. *Polar Research* 8:43-54.
- HUNTER, S. 1983. The food and feeding ecology of the giant petrels *Macronectes halli* and *M. giganteus* at South Georgia. *Journal of the Zoological Society of London* 200:521-538.
- HURTUBIA, J. 1973. Trophic diversity measurement in sympatric predatory species. *Ecology* 54:885-890.
- IMBER, M. J. 1973. The food of Grey-faced Petrels (*Pterodroma macroptera gouldi*) with special reference to diurnal vertical migration of their prey. *Journal of Animal Ecology* 42:645-662.
- IMBER, M. J. 1976. Comparison of prey of the black *Procellaria* petrels of New Zealand. *New Zealand Journal of Marine and Freshwater Research* 10:119-130.
- IMBER, M. J. 1981. Diets of storm petrels *Pelagodroma* and *Garrodia* and of prions *Pachyptila* (procellariids): ecological separation and bill morphology. Pp. 63-88 in J. Cooper (editor). *Proceedings of the symposium of birds of the sea and shore, 1979*. African Seabird Group, Capetown, Republic of South Africa.

- IMBER, M. J. 1995. Food of three sympatric gadfly petrels (*Pterodroma* spp.) breeding on the Pitcairn Islands. *Biological Journal of the Linnean Society* 56:233–240.
- IMBER, M. J. 1996. The food of Cook's Petrel *Pterodroma cookii* during its breeding season on Little Barrier Island, New Zealand. *Emu* 96:189–194.
- IMBER, M. J., AND A. BERRUTI. 1981. Procellariiform seabirds as squid predators. Pp. 43–61 in J. Cooper (editor), *Proceedings of the symposium of birds of the sea and shore, 1979*. African Seabird Group, Capetown, Republic of South Africa.
- IMBER, M. J., J. B. CRUZ, J. S. GROVE, R. J. LAVENBERG, C. C. SWIFT, AND F. CRUZ. 1992. Feeding ecology of the Galápagos Petrel in the Galápagos Islands. *Condor* 94:437–447.
- IMBER, M. J., AND R. RUSS. 1975. Some foods of the Wandering Albatross *Diomedea exulans*. *Notornis* 22:27–36.
- JACKSON, S. 1988. Diets of the White-chinned Petrel and Sooty Shearwater in the southern Benguela region, South Africa. *Condor* 90: 20–28.
- JACKSON, S., AND P. G. RYAN. 1986. Differential digestion rates of prey by White-chinned Petrels (*Procellaria aequinoctialis*). *Auk* 103:617–619.
- JOHNSTON, D. W. 1956a. The annual reproductive cycle of the California Gull II. Histology and female reproductive system. *Condor* 58: 206–221.
- JOHNSTON, D. W. 1956b. The annual reproductive cycle of the California Gull I. Criteria of age and the testis cycle. *Condor* 58:134–162.
- KING, W. B. 1970. The trade wind zone oceanographic pilot study, Part VII: observations of seabirds March 1964 to June 1965. USDI Fish and Wildlife Service, Special Report 586:1–136.
- KAWAGUCHI, K., H. IKEDA, M. TAMURA, AND S. UYANGI. 1972. Geographical distribution of surface-migrating fishes (genus *Myctophum*) in the tropical and subtropical Pacific and Indian oceans. *Bulletin of Far Seas Research Laboratory* 6:23–37.
- LIPINSKI, M. R., AND S. JACKSON. 1989. Surface-feeding on cephalopods by procellariiform seabirds in the Benguela region, South Africa. *Journal of the Zoological Society of London* 218:549–563.
- LONGHURST, A. R., AND D. PAULY. 1987. *Ecology of tropical oceans*. Academic Press, San Diego, CA.
- MARCHAL, E., AND A. LEBOURGES. 1996. Acoustic evidence for unusual diel behaviour of a mesopelagic fish (*Vinciguerria nimbaria*) exploited by tuna. *ICES Journal of Marine Science* 53:443–447.
- MARSHALL, N. B. 1960. Swimbladder structure of deep-sea fishes in relation to their systematics and biology. *Discovery Report* 31: 1–122.
- MAURY, O., AND P. LEHODEY. 2005. Background and rationale. Pp. 6–8 in *Climate impacts on ocean top predators (CLIOTOP)*. Science Plan and Implementation Strategy. GLOBEC Report No. 18. London, UK.
- MAYNARD, S. D., F. V. RIGGS, AND J. F. WALTERS. 1975. Mesopelagic micronekton in Hawaiian waters: faunal composition, standing stock, and diel vertical migration. *Fishery Bulletin* 73:726–736.
- MCGOWAN, J. A., AND P. W. WALKER. 1993. Pelagic diversity patterns. Pp. 203–214 in R. E. Ricklefs, and D. Schluter (editors). *Species diversity in ecological communities*. University of Chicago Press, Chicago, IL.
- MORZER BRUYNS, W. F. J., AND K. H. VOOUS. 1965. Night-feeding of Sooty Tern. *Ardea* 53:79.
- MURPHY, G. L., AND R. S. SHOMURA. 1972. Pre-exploitation abundance of tunas in the equatorial central Pacific. *Fisheries Bulletin* 70: 875–913.
- MYERS, R. A., AND B. WORM. 2003. Rapid worldwide depletion of predatory fish communities. *Nature* 423:280–283.
- NAGY, K. A. 1987. Field metabolic rate and food requirement scaling in mammals and birds. *Ecological Monographs* 57:111–128.
- NAKAMURA, E. L. 1970. Observations on the biology of the myctophid, *Diaphus garmani*. *Copeia* 2:374–377.
- NESIS, K. N. 1987. *Cephalopods of the World*. T. F. H. Publishers, Ltd. London, UK.
- NEVITT, G. A. 1999. Foraging by seabirds on an olfactory landscape. *American Scientist* 87: 46–53.
- OHIZUMI, H., H. WATANABE, M. MOKU, AND S. KAWAHARA, S. 2001. Species identification for otoliths of myctophid fishes in the western North Pacific. *Aquabiology* 137:626–637.
- OLSON, R. J., AND G. M. WATTERS. 2003. A model of the pelagic ecosystem in the eastern tropical Pacific Ocean. *Bulletin of the Inter-American Tropical Tuna Commission* 22: 133–218.
- PEARSON, T. H. 1968. The feeding ecology of seabird species breeding on the Farne Islands, Northumberland. *Journal of Animal Ecology* 37:521–552.
- PITMAN, R. L., AND L. T. BALLANCE. 1990. Daytime feeding by Leach's Storm-Petrel on a mid-water fish in the eastern tropical Pacific. *Condor* 92:524–527.
- PRINCE, P. A., N. HUIN, AND H. WEIMERSKIRCH. 1994. Diving depths of albatrosses. *Antarctic Science* 6:353–354.

- RAU, G. H., D. G. AINLEY, J. L. BENGTSON, J. J. TORRES, AND T. L. HOPKINS. 1992. $^{15}\text{N}/^{14}\text{N}$ and $^{13}\text{C}/^{12}\text{C}$ in Weddell Sea birds, seals, and fish: implications for diet and trophic structure. *Marine Ecology Progress Series* 84:1-8.
- RODHOUSE, P. G., M. C. CLARKE, AND A. W. A. MURRAY. 1987. Cephalopod prey of the wandering albatross *Diomedea exulans*. *Marine Biology* 96:1-10.
- RIBIC, C. A., AND D. G. AINLEY. 1997. The relationships of seabird assemblages to physical habitat features in Pacific equatorial waters during spring 1984-1991. *ICES Journal of Marine Science* 54:593-599.
- RIBIC, C. A., D. G. AINLEY, AND L. B. SPEAR. 1997. Seabird associations in Pacific equatorial waters. *Ibis* 139:482-487.
- ROGER, C. 1994. Relationship among yellowfin and skipjack tuna, their prey and plankton in the tropical west Indian Ocean. *Fisheries Oceanography* 3:133-144.
- ROPER, C. F. E., AND R. E. YOUNG. 1975. Vertical distribution of pelagic cephalopods. *Smithsonian Contributions to Zoology* 209:1-51.
- SAS INSTITUTE, INC. 1985. SAS user's guide: statistics. 5th Edition. SAS Institute Inc., Cary, NC.
- SCHINDLER, D. E., T. E. ESSINGTON, J. F. KITCHELL, C. BOGGS, AND R. HILBORN. 2002. Sharks and tunas: fisheries impacts on predators with contrasting life histories. *Ecological Applications* 12:735-748.
- SCHNEIDER, D. C., AND G. L. HUNT, JR. 1984. A comparison of seabird diets and foraging distributions around the Pribilof Islands, Alaska. Pp. 86-95 in *Marine birds: their feeding ecology and commercial fisheries relationships*. Special Publications of the Canadian Wildlife Service, Ottawa, Canada.
- SCHREIBER, R. W., AND D. A. HENSLEY. 1976. The diets of *Sula dactylatra*, *Sula sula*, and *Fregata minor* on Christmas Island, Pacific Ocean. *Pacific Science* 30:241-248.
- SHANNON, C. E. 1948. A mathematical theory of communication. *Bell Systems Technical Journal* 27:379-423, 623-656.
- SMALE, M. J., G. WATSON, AND T. HECHT. 1995. Otolith atlas of southern African marine fishes. *Ichthyological Monographs* 1, J. L. B. Smith Institute of Ichthyology, Grahamstown, Republic of South Africa.
- SPEAR, L. B., AND D. G. AINLEY. 1993. Kleptoparasitism by Kermadec Petrels, jaegers, and skuas in the eastern tropical Pacific: evidence of mimicry by two species of *Pterodroma*. *Auk* 110:223-233.
- SPEAR, L. B., AND D. G. AINLEY. 1997a. Flight behaviour of seabirds in relation to wind direction and wing morphology. *Ibis* 139: 221-233.
- SPEAR, L. B., AND D. G. AINLEY. 1997b. Flight speed of seabirds in relation to wind speed and direction. *Ibis* 139:234-251.
- SPEAR, L. B., AND D. G. AINLEY. 1998. Morphological differences relative to ecological segregation in petrels (Family: Procellariidae) of the Southern Ocean and tropical Pacific. *Auk* 115:1017-1033.
- SPEAR, L. B., AND D. G. AINLEY. 2005. At-sea behaviour and habitat use by tropicbirds (Phaethontidae) in the eastern Pacific. *Ibis* 147: 391-407.
- SPEAR, L. B., AND D. G. AINLEY. 2007. Storm-petrels of the eastern Pacific Ocean: Species diversity and assembly along habitat gradients. *AOU Monograph No. 62*.
- SPEAR, L. B., D. G. AINLEY, B. D. HARDESTY, S. N. G. HOWELL, AND S. W. WEBB. 2005. Reducing biases affecting at-sea surveys of seabirds: use of multiple observer teams. *Marine Ornithology* 32:147-157.
- SPEAR, L. B., D. G. AINLEY, N. NUR, AND S. N. G. HOWELL. 1995. Population size and factors affecting at-sea distribution of four endangered procellariids in the tropical Pacific. *Condor* 97:613-638.
- SPEAR, L. B., L. T. BALLANCE, AND D. G. AINLEY. 2001. Response of seabirds to thermal boundaries in the tropical Pacific: the thermocline vs. the Equatorial Front. *Marine Ecology Progress Series* 219:275-289.
- SPEAR, L., N. NUR, AND D. G. AINLEY. 1992. Estimating absolute densities of flying seabirds using analyses of relative movement. *Auk* 109:385-389.
- S-PLUS. 1997. S-PLUS 4 guide to statistics. Data Analysis Products Division, MathSoft. Seattle, WA.
- STATA CORPORATION. 1995. STATA reference manual: release 5.1, 6th edition. Stata Corporation, College Station, TX.
- SWARTZMAN, G., C. HUANG, AND S. KALUZNY. 1992. Spatial analysis of Bering Sea groundfish survey data using generalized additive models. *Canadian Journal of Fisheries and Aquatic Sciences* 49:1366-1378.
- TRENBERTH, K. E. 1997. The definition of El Niño. *Journal of the American Meteorological Society* 78:2771-2777.
- USDI FISH AND WILDLIFE SERVICE. 1983. Hawaiian Petrel and Newell's Shearwater recovery plan. Portland, OR.
- USPENSKI, V. S. 1956. The bird bazaars of Novaya Zemlya. (CWS Translation of Russian Game Reports) Academy of Science: Volume 4. Moscow, Russia.
- WALKER, W. A., J. G. MEAD, AND R. L. BROWNELL, JR. 2002. Diets of Baird's beaked whales, *Berardius bairdii*, in the southern Sea of

- Okhotsk and off the Pacific coast of Honshu, Japan. *Marine Mammal Science* 18:902-919.
- WATANABE, H., M. MOKU, K. KAWAGUCHI, K. ISHIMARU, AND A. OHNO. 1999. Diel vertical migration of myctophid fishes (family Myctophidae) in the transitional waters of the western North Pacific. *Fisheries Oceanography* 8:115-127.
- WEIMIRSKIRCH, H., M. LE CORRE, S. JAQUEMET, M. POTIER, AND F. MARSAC. 2004. Foraging strategy of a top predator in tropical waters: Great Frigatebirds in the Mozambique Channel. *Marine Ecology Progress Series* 275:297-308.
- WEISNER, R. L. 1974. The taxonomy and distribution of lanternfishes (family Myctophidae) of the eastern Pacific Ocean. Naval Ocean Research and Development Activity Report 3, Stennis Field, MS.
- WENZEL, B. M. 1980. Chemoreception in seabirds. Pp. 41-64 in J. Burger, B. L. Olla, and H. E. Winn (editors). *Behavior of marine animals*, Volume 4. Plenum Press, New York, NY.
- WOLFF, G. A. 1982. A beak key for eight eastern tropical Pacific cephalopod species with relationships between their beak dimensions and size. *Fishery Bulletin* 80:357-371.
- WOLFF, G. A. 1984. Identification and estimation of size from the beaks of 18 species of cephalopods from the Pacific Ocean. U.S. National Oceanic and Atmospheric Association, National Marine Fisheries Service, Technical Report 17, La Jolla, CA.
- WORMUTH, J. H., AND C. F. E. ROPER. 1983. Quantitative sampling of oceanic cephalopods by nets: problems and recommendations. *Biological Oceanography*, Volume 2. Crane, Russak & Co, Inc., New York, NY.
- WYRTKI, K. 1966. Oceanography of the eastern equatorial Pacific Ocean. *Oceanography Marine Biology Annual Review* 4:33-68.