

Multiple visits of individual humpback whales (*Megaptera novaeangliae*) between the Hawaiian and Japanese winter grounds

Dan R. Salden, Louis M. Herman, Manami Yamaguchi, and Fumihiko Sato

Abstract: We document through photographic identifications three humpback whale (*Megaptera novaeangliae*) winter ground interchanges between Hawai'i and Japan. Two of these whales, identified as male by their behavioral roles, made multiple interchanges across years; i.e., they were initially seen in Hawai'i, were later observed in Japan, and subsequently, returned to Hawai'i. The third whale was seen in only 2 different years, once in Japan and then in Hawai'i. Prior to this report, there has been only one published report of a Hawai'i–Japan interchange and only eight between Hawai'i and Mexico. None of these involved multiple interchanges. The current findings demonstrate that individual whales may be highly flexible in their annual choice of widely separated winter destinations and suggest that these wanderers may be mainly males. The occurrence of wanderers provides a mechanism for increasing genetic variability in the breeding populations and also suggests a mechanism for noted song similarities across different North Pacific winter grounds.

Résumé : Des photographies nous ont permis de reconnaître trois Rorquals à bosse (*Megaptera novaeangliae*) qui sont passés de territoires d'hiver d'Hawai'i à des territoires d'hiver japonais et vice versa. Deux de ces rorquals, des mâles d'après leur comportement, ont fait plusieurs traversées au cours des années, c'est-à-dire qu'ils ont d'abord été aperçus à Hawai'i, puis ont été vus au Japon, et subséquemment sont retournés à Hawai'i. Le troisième rorqual a été vu seulement au cours de 2 années, une fois au Japon, l'autre fois à Hawai'i. Il n'existe qu'une seule mention préalable d'un déplacement Hawai'i–Japon et seulement huit de déplacements Hawai'i–Mexique. Aucune de ces publications ne mentionne de déplacements multiples. Les résultats publiés ici démontrent que les rorquals peuvent faire preuve d'une grande flexibilité dans leur choix annuel entre des destinations d'hiver très éloignées les unes des autres et semblent indiquer que ces individus errants sont surtout des mâles. L'errance constitue un mécanisme d'augmentation de la variabilité génétique chez les populations reproductrices et explique probablement la similarité des chants dans les différents quartiers d'hiver dans le nord du Pacifique.

[Traduit par la Rédaction]

Introduction

Humpback whales (*Megaptera novaeangliae*) annually travel thousands of kilometers between high-latitude summer feeding grounds and low-latitude winter reproductive grounds. Three major winter destinations of North Pacific humpback whales have been identified. The Mexican grounds include the southern coast of Baja, the northern Gulf of California, portions of the western mainland coast of Mexico, and the waters of the Revillagigedo Islands (Urbán and Aguayo 1987). The Hawaiian grounds consist of the waters around the main Hawaiian Islands (Herman and Antinaja 1977; Herman et al. 1980). The Japanese grounds include the wa-

ters adjacent to the Ryukyu Islands and Ogasawara (Bonin) Islands (Nishiwaki 1966; Darling and Mori 1993).

Photoidentification of the uniquely patterned, ventral surface of humpback whale tail flukes has proven to be a reliable method for determining individual identity (Katona et al. 1979; Perry et al. 1988). Trends in migratory destinations and site fidelity of individual animals or populations of animals have been documented through the use of fluke photographs taken in various North Pacific regions in the same or different years (e.g., Darling and Jurasz 1983; Darling and McSweeney 1985; Baker et al. 1986; Urbán and Aguayo 1987; Perry et al. 1990; Steiger et al. 1991; Calambokidis et al. 1996; Craig and Herman 1997). Many individual whales have been photographed in a given winter ground over multiple years. In contrast, only eight individual whales have been identified thus far as visiting both the Hawaiian and the Mexican winter grounds. Three of these interchanges were reported earlier (Darling and Jurasz 1983; Darling and McSweeney 1985; Baker et al. 1986). More recently, Calambokidis et al. (1997) discovered five additional interchanges between Mexico and Hawai'i based on photographic data from the years 1991–1993.

Presently, there is only one published report of a humpback whale visiting both the Japanese and Hawaiian winter grounds (Darling and Cerchio 1993). This whale was photographed initially off Ogasawara, Japan, in April 1990, and

Received August 11, 1998. Accepted December 3, 1998.

D.R. Salden.¹ Hawai'i Whale Research Foundation, Southern Illinois University Edwardsville, Edwardsville, Ill 62026-1772, U.S.A.

L.M. Herman. Kewalo Basin Marine Mammal Laboratory, University of Hawai'i, 1129 Ala Moana Boulevard, Honolulu, HI 96814, U.S.A.

M. Yamaguchi and F. Sato. Ogasawara Marine Center, Byobundami, Chichi-jima, Ogasawara-mura, Tokyo 100-21, Japan.

¹Author to whom all correspondence should be addressed (e-mail: dsalden@siue.edu).

Table 1. Sighting histories of three humpback whales observed in both the Japanese and Hawaiian winter grounds.

OMC ID no.	Date sighted	Sighted by	Location	Group size	Behavior role
O-275 ^a	6 Mar 1982	KBMML	Big Island	Singleton	Singer
	25 Feb 1984	HWRF	Maui	2 adults	
	27 Feb 1984	KBMML	Big Island	2 adults	Secondary escort
	15 Apr 1988	KBMML	Big Island	Mother-calf, 3 escorts	
	21 Mar 1990	KBMML	Big Island	Mother-calf, 1 escort	Escort
	6 Mar 1991	HWRF	Maui	4 adults	Escort
	6 Mar 1991	HWRF	Maui	Mother-calf, 3 escorts	
	10 Mar 1992	OMC	Chichi-jima	2 adults	Escort
	11 Mar 1992	OMC	Chichi-jima	2 adults	
	27 Mar 1992	OMC	Muko-jima	2 adults	Escort
	27 Mar 1992	OMC	Muko-jima	2 adults	
	29 Mar 1992	OMC	Chichi-jima	Singleton	Escort
	1 Feb 1993	KBMML	Big Island	3 adults	
	O-168 ^b	5 Mar 1988	KBMML	Big Island	3 adults
8 Mar 1988		KBMML	Big Island	3 adults	
7 Mar 1991		OMC	Haha-jima	4 adults	Primary escort
9 Mar 1991		OMC	Chichi-jima	4 adults	
27 Mar 1991		OMC	Chichi-jima	2 adults	Escort
30 Mar 1991		OMC	Chichi-jima	5 adults	
1 Apr 1991		OMC	Chichi-jima	Mother-calf, 2 escorts	Escort
1 Apr 1991		OMC	Chichi-jima	4 adults	
2 Apr 1993		KBMML	Big Island	3 adults	Member, competitive group
18 Apr 1996		HWRF	Maui	Mother-calf, 3 escorts	
17 Feb 1997		HWRF	Maui	10 adults	Primary escort
6 Apr 1997		KBMML	Maui	Mother-calf, 6 escorts	
6 Apr 1997		KBMML	Maui	2 adults	Secondary escort
9 Apr 1997		KBMML	Maui	Mother-calf, 1 escort	
O-210 ^c	28 Feb 1991	OMC	Chichi-jima	2 adults	Escort
	17 Feb 1993	KBMML	Big Island	Singleton	

^aThis whale is catalogued by KBMML as resight No. 364 and by HWRF as No. 84009.

^bThis whale is catalogued by KBMML as resight No. 1000 and by HWRF as No. 96002.

^cThis whale is catalogued by KBMML as observation No. 8632. It has not been catalogued by HWRF.

subsequently off Kauai in February 1991. In Japan, the whale was seen twice as an escort to a mother-calf pair, and in Hawai'i, it was a member of a competitive group. Both of these behaviors have been associated almost exclusively with males (Glockner 1983; Baker and Herman 1984).

This note documents three additional North Pacific humpback whales that visited both the Hawaiian and Japanese winter grounds. More importantly, two of the whales made multiple interchanges between the two winter grounds over a span of 10 or 12 years, for which sighting records were available. Such repeated interchanges, if they result in the reproductive success of these winter wanderers, can potentially enhance the genetic variability of the North Pacific humpback whale stock (cf. Donovan 1991).

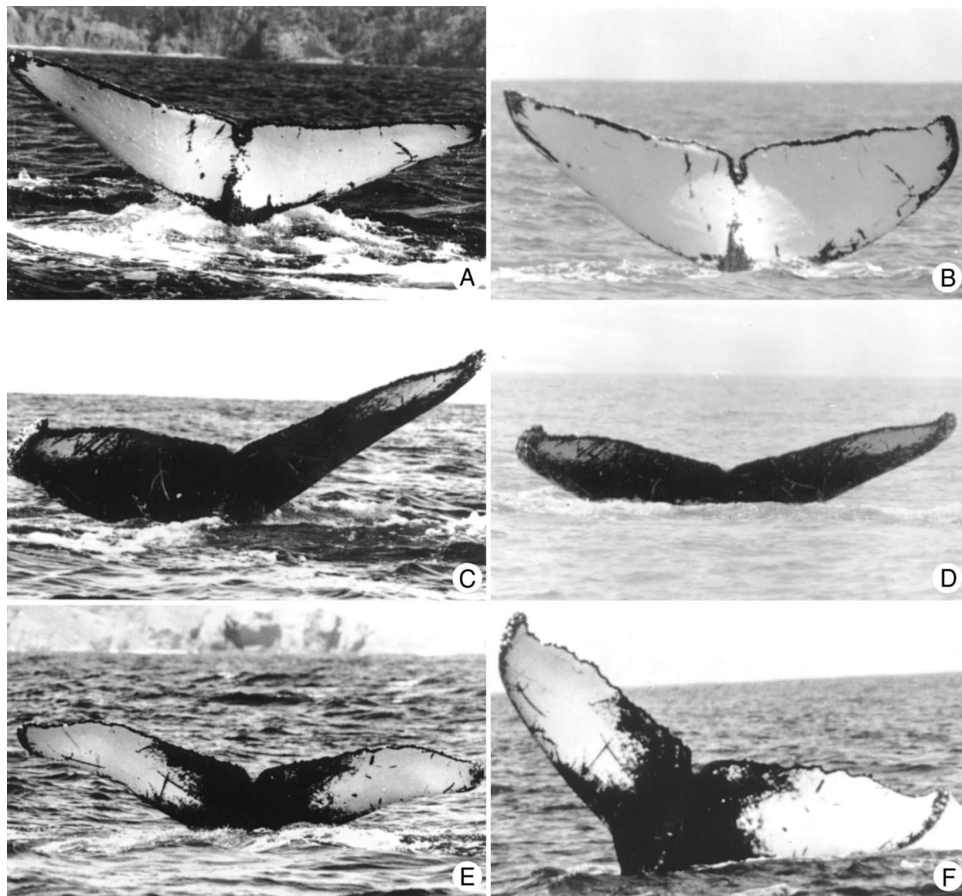
Table 1 summarizes the resight histories for the three whales documented in this note. One resight (whale O-275) resulted from an exchange of fluke photographs by the Hawai'i Whale Research Foundation (HWRF) and the Ogasawara Marine Center (OMC). Two additional resights, identified here as whales O-168 and O-210, and an additional sighting of O-275 were uncovered as part of a mark-recapture study conducted to estimate humpback whale population abundance for the North Pacific Ocean (Calambokidis et al. 1997). In this study, researchers from the United States, Canada, Mexico, and Japan submitted humpback whale fluke photographs for the years 1991–1993. The resightings of whales O-275,

O-168, and O-210 were based on 401 unique flukes photographed by the Kewalo Basin Marine Mammal Laboratory (KBMML), 368 submitted by HWRF, and 275 submitted by OMC. The fieldwork of OMC was concentrated in the waters around Ogasawara Gunto, including the islands of Muko-jima, Chichi-jima, and Haha-jima (referred to here as Japan). The efforts of HWRF were concentrated in the waters between the four islands of Maui, Lanai, Molokai, and Kahoolawe (collectively referred to as Maui). The efforts of KBMML were concentrated in the waters along the northwest coast of the island of Hawai'i (the Big Island), as well as in the waters of Maui. Additional sightings, ranging from 1982 to 1997, were uncovered through searches of the extensive fluke photograph catalogs of KBMML and HWRF. Representative identification photographs of the three whales are presented in Fig. 1.

Whale O-275

The most interesting finding for this whale is the across-region consecutive-year winter sightings from 1990 to 1993. In 1990, O-275 was photographed off the Big Island. In 1991, it was observed off Maui, and in 1992, it was seen at several locations in Japan. In 1993, O-275 was back at the Big Island again. Altogether, over the period from 1982 to 1993, O-275 was seen 13 times (8 times in Hawai'i over 6

Fig. 1. Fluke identification photographs of whale O-168 off Ogasawara, Japan (A), and Big Island, Hawai'i (B); whale O-210 off Ogasawara (C) and Big Island, Hawai'i (D); and whale O-275 off Ogasawara (E) and Maui, Hawai'i (F). Photographs A, C, and E are from OMC; photographs B and D are from KBMML; and photograph F is from HWRF.



different years and 5 times in Japan during 1992). There are no sighting records in our catalogs earlier than 1976 or later than 1997 (Table 1). There is also a 4-year gap in sightings from February 1985 to April 1988. However, photographic data from Japan were available only for the years 1991–1993. It is possible that some of these gaps or other shorter gaps may represent winter periods when O-275 was in Japanese waters. It is also possible that O-275 was in Hawai'i but was missed.

The behavior and social roles of O-275 strongly suggest that it is a male. In 1982, O-275 was observed as a singer, and on three occasions (1988, 1990, and 1991) was acting as an escort in a mother–calf pod. Singers and escorts have been reliably sexed as males (Glockner 1983; Tyack and Whitehead 1983; Baker and Herman 1984). Additionally, O-275 was never seen with its own calf.

Whale O-168

Whale O-168 was seen off the Big Island in 1988, in Japan in 1991, and again off the Big Island in 1993. Altogether, O-168 was seen a total of 14 times from 1988 to 1997 (8 times in Hawai'i over 4 different years and 6 times in Japan during 1991). The largest gap in sightings was 2 years (i.e., 1989–1990 and 1994–1995), but there are no data

from Japan for these years. Also, there are no sighting records of O-168 in the Hawai'i fluke catalogs prior to 1988.

On 5 March 1988, O-168 was in a group of three adults exhibiting head lunging behaviors (the head appears out of the water as the whale lunges forward, usually with throat pleats partially inflated). Head lunging is commonly seen among multiple escorts engaged in agonistic behaviors (e.g., Baker and Herman 1984). O-168 was also seen in Japan as one of two escorts to a mother–calf pair during the 1991 season. In 1996 off Maui, O-168 was the primary escort (Tyack and Whitehead 1983) in a competitive group of three escorts accompanying a mother–calf pair. Finally, in 1997, also off Maui, O-168 was seen three times, twice as an escort to a mother–calf pair and once within a competitive group of 10 adults. The behavior and social roles of O-168 suggest that it, like O-275, is a male.

Whale O-210

Whale O-210 has been seen only twice. An extensive review of our Hawai'i fluke catalogs failed to find any additional sightings. Initially, O-210 was seen with one other adult off Chichi-jima on 28 February 1991. Two years later, on 1 February 1993, O-210 was seen in a group of three adults off the northern Kohala Coast of Hawai'i. The group

was milling without exhibiting any obvious competitive behavior. In neither of these sightings was the gender of whale O-210 identified or inferable behaviorally.

Implications

A comparison of sightings of the three humpback whales reveals that (i) O-275 and O-168 were both present at the Big Island in 1988; (ii) O-168 and O-210 were both present in Japan in 1991; and (iii) all three whales were observed off the Big Island in 1993. An overlap in same-year sightings, but on different winter grounds, occurred in 1991 for O-275, seen in Maui, and O-168, seen in Japan. There were no other years with sightings of more than one of these whales. Although there is some overlap in appearances of two or three of the whales at the same winter grounds in the same years, the data are too few to conclude that there are any common influences on the migratory patterns or destinations of these whales.

These sightings provide substantial evidence of repeated visits of North Pacific humpback whales between winter grounds in Hawai'i and Japan. In the southeastern Pacific, Florez-Gonzalez et al. (1998) reported sightings of one whale in the Colombian winter grounds in 1986, in the Ecuadorian winter grounds in 1988, and then again in the Colombian grounds in 1990. However, these southeastern Pacific winter grounds are separated by only 560 km as compared with the approximate 6420 km distance separating Hawai'i (Maui) and the Ogasawara Japanese grounds. It is evident, therefore, that humpback whales may range over enormous distances in their migration. For example, based on sighting data from 1990 to 1995, Darling et al. (1996) reported two round trips of a single whale between the Japan winter grounds and the summer grounds off British Columbia, a distance of approximately 7900 km. Unfortunately, the summer feeding grounds of the three whales discussed in this note remain unknown. A review of the KBMML humpback whale fluke catalog (Perry et al. 1988) and the updated (through 1996) SAS data base maintained by KBMML show no matches between these whales and other whales photographed in southeast Alaska or in portions of the Gulf of Alaska. Similarly, no matches for these whales were found within the catalog of 851 whales recently identified photographically in southeast Alaska between 1979 and 1997 by Straley and Gabriele (1998). Also, no matches to feeding ground sightings were found within the extensive fluke data base maintained by the National Marine Mammal Laboratory (NMML). Between 500 and 800 candidate flukes generated by the NMML program were checked for the three whales without success. The whale reported by Darling et al. (1996), identified as a female, is not any of the three reported here or the whale reported by Darling and Cerchio (1993).

Two of the three whales reported here assumed social roles and exhibited behaviors typical of males. The whale reported by Darling and Cerchio (1993) was also believed to be male. If male humpback whales are the predominant winter wanderers, it may reflect the apparent surplus of males in the winter grounds, and the consequent increased pressures to seek and mate with females. Craig and Herman (1997) reported a male:female ratio of 1.86:1 for Hawai'i and Brown

et al. (1995) reported a ratio of 2.4:1 for whales migrating off the east coast of Australia to and from the northern winter grounds. In contrast, the sex ratio is about 1:1 in the summer feeding grounds (e.g., Clapham et al. 1993). A greater likelihood for males to shift among winter grounds is consistent with the observation of Palumbi and Baker (1994) that increased nuclear allele mixing (as opposed to mitochondrial allele mixing) observed among the Hawai'i and California subpopulations suggests that males tend to move more between winter breeding grounds than do females. Male interchanges between winter grounds would also offer a direct mechanism for the noted similarities in song characteristics in different North Pacific winter grounds (Payne and Guinee 1983; Helweg et al. 1991).

Additional effort to compare fluke photographs across winter regions is necessary to gain a better understanding of the extent of interchanges between North Pacific winter grounds, the gender of the wanderers, and what such interchanges may imply about the discreteness of populations.

Acknowledgements

Research support and funding for the HWRF has come from Captain Zodiac (Kauai and Hawai'i), Sea World, Tokyo Broadcasting System, UFO Chuting of Hawai'i Inc., Whale Aid of Hawai'i, and Southern Illinois University Edwardsville. D.R.S. would like to acknowledge the assistance rendered by Jim Darling in establishing initial contacts with the OMC. Matt Biondi, Phil Colla, David Glickman, Jeff Kalbach, Jill Mickelsen, Linda E. Silvers, and Harrison A. Stubbs provided invaluable assistance with the collection of data. KBMML support has come from the Earthwatch Institute and The Dolphin Institute. KBMML thanks the many Earthwatch volunteers who assisted in the research, as well as the many students and KBMML staff who contributed their time and effort over the years. Alison Craig coordinated the extensive fluke-matching effort for KBMML, and along with Scott Spitz and Adam Pack, provided helpful comments on an earlier draft. OMC support has come from the Ogasawara Village. OMC also acknowledges the research assistance provided by Kyoichi Mori, as well as the many volunteers who helped in the OMC research effort.

References

- Baker, C.S., and Herman, L.M. 1984. Aggressive behavior between humpback whales (*Megaptera novaeangliae*) wintering in Hawaiian waters. *Can. J. Zool.* **62**: 1922-1937.
- Baker, C.S., Herman, L.M., Perry, A., Lawton, W.S., Straley, J.M., Wolman, A.A., Kaufman, G.D., Winn, H.E., Hall, J.D., Reinke, J.M., and Östman, J. 1986. Migratory movement and population structure of humpback whales (*Megaptera novaeangliae*) in the central and eastern North Pacific. *Mar. Ecol. Prog. Ser.* **31**: 105-119.
- Brown, M.R., Corkeron, P.J., Hale, P.T., Schultz, K.W., and Bryden, M.M. 1995. Evidence for a sex-segregated migration in the humpback whale (*Megaptera novaeangliae*). *Proc. R. Soc. Lond. Ser. B. Biol. Sci.* **259**: 229-234.
- Calambokidis, J., Steiger, G.H., Evenson, J.R., Flynn, K.R., Balcomb, K.C., Claridge, D.E., Bloedel, P., Straley, J.M., Baker, C.S., von Ziegeler, O., Dahlheim, M.E., Waite, J.M., Darling, J.D., Ellis, G., and Green, G.A. 1996. Interchange and isolation

- of humpback whales off California and other North Pacific feeding grounds. *Mar. Mamm. Sci.* **12**: 215–226.
- Calambokidis, J., Steiger, G.H., Straley, J.M., Quinn, T., Barlow, J., Herman, L.M., Cerchio, S., Salden, D.R., Yamaguchi, M., Sato, F., Urbán, J., Jacobsen, R.J., von Ziegler, O., Balcomb, K.C., Gabriele, C.M., Dahlheim, M.E., Higashi, N., Ford, J.K.B., Miyamura, Y., Ladrón de Guevara, P., Mizroch, S.A., Schlender, L., and Rasmussen, K. 1997. Population, abundance, and structure of humpback whales in the North Pacific Basin. Draft final report to Southwest Fisheries Science Center, La Jolla, Calif. by Cascadia Research Collective, 218 1/2 West Fourth Avenue, Olympia, Wash.
- Clapham, P.J., Mattila, D.K., and Palsbøll, P.J. 1993. High-latitude-area composition of humpback whale competitive groups in Samana Bay: further evidence for panmixis in the North Atlantic population. *Can. J. Zool.* **71**: 1065–1066.
- Craig, A.S., and Herman, L.M. 1997. Sex differences in site fidelity and migration of humpback whales (*Megaptera novaeangliae*) to the Hawaiian Islands. *Can. J. Zool.* **75**: 1923–1933.
- Darling, J.D., and Cerchio, S. 1993. Movement of a humpback whale (*Megaptera novaeangliae*) between Japan and Hawai'i. *Mar. Mamm. Sci.* **9**: 84–89.
- Darling, J.D., and Jurasz, C.M. 1983. Migratory destinations of North Pacific humpback whales (*Megaptera novaeangliae*). In *Communication and behavior of whales*. Edited by R. Payne. Westview Press, Boulder, Colo. pp. 359–368.
- Darling, J.D., and McSweeney, D.J. 1985. Observations on the migrations of North Pacific humpback whales (*Megaptera novaeangliae*). *Can. J. Zool.* **63**: 308–314.
- Darling, J.D., and Mori, K. 1993. Recent observations of humpback whales (*Megaptera novaeangliae*) in Japanese waters off Ogasawara and Okinawa. *Can. J. Zool.* **71**: 325–333.
- Darling, J.D., Calambokidis, J., Balcomb, K.C., Bloedel, P., Flynn, K., Mochizuki, A., Mori, K., Sato, F., Suganuma, H., and Yamaguchi, M. 1996. Movement of a humpback whale (*Megaptera novaeangliae*) from Japan to British Columbia and return. *Mar. Mamm. Sci.* **12**: 281–287.
- Donovan, G.P. 1991. A review of IWC stock boundaries. *Rep. Int. Whaling Comm. Spec. Issue No. 13*. pp. 39–68.
- Florez-Gonzalez, L., Capelia, A.J., Haase, B., Bravo, G.A., Felix, F., and Gerrodette, T. 1998. Changes in winter destination and the northernmost record of southeastern Pacific humpback whales. *Mar. Mamm. Sci.* **14**: 189–196.
- Glockner, D.A. 1983. Determining the sex of humpback whales (*Megaptera novaeangliae*) in their natural environment. In *Communication and behavior of whales*. Edited by R. Payne. Westview Press, Boulder. pp. 223–258.
- Helweg, D.A., Herman, L.M., Yamamoto, S., and Forestell, P.H. 1991. Comparison of songs of humpback whales (*Megaptera novaeangliae*) recorded in Japan, Hawai'i, and Mexico during the winter of 1989. *Sci. Rep. Cetacean Res.* **1**: 1–12.
- Herman, L.M., and Antinaja, R.C. 1977. Humpback whales in the Hawaiian breeding waters: population and pod characteristics. *Sci. Rep. Whales Res. Inst. (Tokyo)*, **29**: 59–85.
- Herman, L.M., Forestell, P.H., and Antinaja, R.C. 1980. Study of the 1976/77 migration of humpback whales into Hawaiian waters: composite description. Final Report (MMC-77/19) to the U.S. Marine Mammal Commission, Washington, D.C. Available from U.S. Technical Information Services, Arlington, Va.
- Katona, S.K., Baxter, B., Brazier, O., Kraus, S., Perkins, J., and Whitehead, H. 1979. Identification of humpback whales by fluke photographs. In *Behavior of marine animals*. Vol. 3. Edited by H.E. Winn and B.L. Olla. Plenum Press, New York. pp. 33–44.
- Nishiwaki, M. 1966. Distribution and migration of the larger cetaceans in the North Pacific as shown by Japanese whaling results. In *Whales, dolphins and porpoises*. Edited by K.S. Norris. University of California Press, Berkeley. pp. 171–191.
- Palumbi, S.R., and Baker, C.S. 1994. Contrasting population structure from nuclear intron sequences and mtDNA of humpback whales. *Mol. Biol. Evol.* **11**: 426–435.
- Payne, R.S., and Guinee, L.N. 1983. Humpback whale (*Megaptera novaeangliae*) songs as an indicator of "stocks". In *Communication and behavior of whales*. Edited by R. Payne. Westview Press, Boulder. pp. 333–358.
- Perry, A., Mobley, J.R., Jr., Baker, C.S., and Herman, L.M. 1988. Humpback whales of the central and eastern North Pacific. A catalog of individual identification photographs. Sea Grant Misc. Rep. UNIHI-SEAGRANT-MR-88-02, University of Hawai'i, Honolulu.
- Perry, A., Baker, C.S., and Herman, L.M. 1990. Population characteristics of individually identified humpback whales in the central and eastern North Pacific: a summary and critique. *Rep. Int. Whaling Comm. Spec. Issue No. 12*. pp. 307–323.
- Steiger, G.H., Calambokidis, J., Sears, R., Balcomb, K.C., and Cabbage, J.C. 1991. Movement of humpback whales between California and Costa Rica. *Mar. Mamm. Sci.* **7**: 306–310.
- Straley, J.M., and Gabriele, C.M. 1998. Humpback whales of southeastern Alaska. University of Alaska Southeast, Sitka.
- Tyack, P., and Whitehead, H. 1983. Male competition in large groups of wintering humpback whales. *Behaviour*, **83**: 132–154.
- Urbán, J., and Aguayo, A. 1987. Spatial and seasonal distribution of the humpback whale, *Megaptera novaeangliae*, in the Mexican Pacific. *Mar. Mamm. Sci.* **3**: 333–344.