

Climate and Weather

The climate of the Point Reyes Peninsula and its immediate environs is characterized by cool, dry, foggy summers and cool, rainy winters. Because there are upwellings of colder waters during the summer, cool temperatures and fog are very common along the coast and seaward. The reverse is generally the case during the winter months, with clear but cool weather that is occasionally interrupted by storms from the southwest. High winds are common in this area, which is generally considered to be both the foggiest and windiest location of the Pacific coast. Winds of more than 100 mph are occasionally recorded. This extreme is due in part to the topography of the Point Reyes headlands. However, gale force winds along the Point Reyes Beach are also common. These high winds are most characteristic of late and early winter, and generally occur out of the north and northwest. Winter storms with accompanying winds usually confront the coast from the southeast, and as the storm system moves inland, the winds move to the northwest. End-of-storm winds out of the northwest are usually the most violent. Drake's Bay provides ships a safe refuge during the strong northwest winds, but this area has the potential for unexpected changes in wind direction due to eddy conditions.

Ocean temperatures generally show little annual variation. For example, the mean monthly surface water temperatures at the Golden Gate Bridge (Fort Point, San Francisco) and at North Farallon Island range from 50.9°F to 60.2°F and 52.2°F to 56.2°F respectively, from January to December (1926-1960).

Marine Biology

The area proposed for this permit lies within the Point Reyes/Farallon Islands Marine Sanctuary, and has had its biology studied extensively.

One of the most spectacular components of the area's wildlife is the concentration of nesting seabirds, with a population exceeding 100,000 pairs. The largest concentration of these pairs exist in the Farrallon Islands, far removed from the project site, but the Point Reyes headlands, Drake's Estero, and Estero de Limantour are also important nesting areas.

The Point Reyes headlands provides nesting locations for the Common Murre, Brandt's Cormorant, Pelagic Cormorant, Pigeon Guillemot, Western Gull, and the Black Oystercatcher. The

population of all these species has been increasing over the recent past and they are not threatened by the proposed project.

Drake's Estero and the Estero de Limantour provide estuarine areas for various diing birds, especially the Black Brant.

Within sight of the project area twenty three species of marine mammals have been sighted, including five pinniped species, 17 cetaceans, and one fissioned (th. Sea Otter). Most of the pinnipeds (seals and sea lions) are year-round inhabitants. Again, the most important part of the sanctuary for these species is the Farallon Islands, where major breeding, pupping, and haul-out areas have been established. Within Drake's Bay, only the Harbor Seal has established haul-out areas, mostly along Limantour Spit.

In contrast, the cetacean (whale) species are all migratory through this area, especially the California Grey Whale which are usually observed each year from late November through June or July. None of the cetacean species noted with the Sanctuary spends time in the shallow waters proposed for this project.

Fish resources are abundant over a wide portion of the Point Reyes and Farallon Islands areas. The area has many factors which make it vital to the health and existence of many species.

The area has many diverse habitats, but as this project is restricted to the nearshore part of Drake's Bay, this study focuses on this particular environment. Several studies describing the fish resources of the entire area can be found in the "Final Environmental Impactment Statement on the Proposed Point Reyes-Farallon Islands Marine Sanctuary" put out by the Federal Office of Coastal Zone Management in 1980.

Drake's Bay is important as a feeding spawning, and nursery area for many fin-fish. In addition, Drake's Estero and the Estero de Limantour provide nurseries for Pacific Herring, smelt, Starry Flounder, Sunfperch and Silver Salmon. Various bottom fish, such as California Halibut, Rex Sole, adult Starry Flounder and occasionally other soles migrate to the Bay at different times of the year. Sharks and rays use the Bay as a feeding ground throughout the year.

Kelp beds, an important marine community, are established within Drake's Bay. The dominant species near the project area is the Bull Kelp (Nerocystis luctkeana), which is an annual

species. Its Winter beds represent only one to five percent of its summer extent. It does not provide the dense substructure or canopy that its better known counterpart, the Giant Kelp, does.

The benthic fauna differs greatly according to habitat type. The project site and surrounding area is smooth, featurless, sandy bottom, with little or no relief. Depending on the severity of the Winter storms, the effect of wave surge can often be felt to the bottom. As a result there is little benthic activity, with burrowing animals predominant. Sand dollars and sea urchins have been noted in the area, but not in the numbers that exist in deeper water.

Transportation and Use

Drake's Bay is outside of the main shipping lanes for San Francisco, but is a sheltered anchorage for many smaller vessels transiting the area. There is also considerable traffic from boats visiting the National Seashore.

While there is little commercial fishing done within the Bay, there is extensive use of the area by party boat anglers and private fisherpersons. The area is included in the Farallon - Point Reyes Marine Sanctuary.

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ENVIRONMENTAL EFFECTS

This project will have no significant environmental effects on the area, and will, if successful, have a beneficial effect (Class IV) on the cultural artifacts.

During the initial search phase small boats using non-destructive instruments will cross the area. Since many private or party boats are already in the area this will not be a significant disturbance to either seabirds or marine mammals in the area. If this search gives good indications small test holes will be made, using small airlifts. While this will disturb benthic invertebrates at the actual site of the holes, the small diameter (6-18 inches) in the relation to the whole of Drake's Bay makes this effect insignificant.

If the ship is found and identified, major excavation could begin. A detailed plan will be filed with the permitting agencies when the site details are known well enough to make such planning meaningful; however, analysis of similar projects indicate that there is no danger of environmental effects.

The first step would be to remove the sand overburden from the main body of the wreck, using directed propellor wash. This will disturb the benthic environment over a few hundred square meters at most, including areas effected by the removed sand. Experience in other areas indicates that the invertebrate fauna will reestablish itself within 6 to 9 months following the end of the project. Under certain conditions, it may be advisable to establish a cofferdam around the site before starting work. This would ensure that no fin-fish or marine mammals would inadvertently enter the site while work was in progress, and would further limit potential damage to the benthos.

The proposed project location is not within any of the kelp beds in Drake's Bay.

The maximum work force would include one major recovery vessel (100 feet long), up to two small skiffs, and possibly a barge. Most of this equipment would be anchored the majority of the time. All are fully self-contained. There will be no discharges to disrupt the water quality of the site. No onshore activity is proposed at this time which could disturb either seabirds or the Harbor Seals.

The remaining issue is the protection and conservation of the San Agustin herself; if she is found. The funding and staff proposed for this project are unquestionably

professionally able to extract the maximum amount of archeological data from the site with a minimum amount of damage. By requiring detailed plans for professional review once the site is precisely located, we are protecting the public trust. The people of California and the nation deserve to have a site of this importance professionally evaluated.

The final phase of this proposal, conservation, is probably the most important. Again, the applicant has agreed to remove nothing from the site until specific provisions for conservation and display or storage are agreed to by the permitting agencies. It is very rare that we are presented with an application with the funding and expertise to provide for a full preservation effort. Staff believes that, if the wreck is found in good condition, a permanent display can be established that meets the needs of State and Federal agencies, and returns a priceless part of California's heritage to public view.

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APPENDIX A

MAJOR OCCUPATIONS AND DIRECTORSHIPS OF CERTAIN OF THE
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CUC Ltd., Cullman Ventures Inc. (U.S.), Dilworth, Secord, Meagher and Associates
Ltd., Huron Chemicals Ltd., Lake Ontario Steel Company Ltd., Planned Investments
Management Ltd., Planned Investments Corp., Pratt & Whitney Aircraft Canada Ltd.,
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APPENDIX B

ROBERT F. MARX

Date of Birth: 8 December 1936, Pittsburgh, Pennsylvania USA
Present Address: 330 Thyme Street
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EDUCATION

Los Angeles City College, June 1951 - September 1953; September 1956-February 1957 (evening classes).
University of Maryland extension courses (during military service)
December 1953 - June 1956 with 90 undergraduate credit hours in total.
Major: Anthropology and Archaeology

FIELDS OF SPECIALIZATION

Marine Archaeology, with particular reference to the Spanish colonial period in the Caribbean.
Naval & Maritime history, with particular reference to Spanish maritime trade - 1500 - 1800.

MILITARY SERVICE

US Marine Corps 1953-56
• In charge of USMC marine salvage operations, East Coast, U.S. 1953-55.
• Director of USMC Diving School, Vieques, Puerto Rico, 1955-56 (training of over 5,000 marines in use of scuba diving and its use in amphibious warfare).
• Honorable Discharge September 1956; USMC Reserves (inactive) 1953-62.

ARCHAEOLOGICAL EXPLORATIONS & RECOVERIES

1. Location of several Civil War blockade runners and recovery of artifacts, under auspices of North Carolina Development Board, 1953-54.
2. Location of Civil War ironclad, USS Monitor, Cape Hatteras, N.C., 1955.
3. Location of a number of Spanish and English wreck sites from period 1650-1800, Puerto Rico and Virgin Islands, 1955-56.

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4. Discovery of a number of previously unknown Mayan temple sites, cenotes, zaches (ceremonial causeways), and cave tombs in British Honduras, Quintana Roo, Isla Cozmel, Mexico; mapping of Tulum, Coba, Xelha, and other little known Mayan cities on the east coast of Quintana Roo, Isla Cozumel, and Isla Mujeres, in cooperation with the Mexican Department of Anthropology and History; first exploration and recovery of artifacts from Mayan cenote at Dzibilchaltun, under direction of Tulane University Department of Archaeology; Assistant Professor John Goggin, University of Florida, in excavation of Spanish colonial sites, Yucatan: February 1957 - September 1959.
5. Discovery of remains of Spanish galleon, Nuestra Senora de los Milagros (sunk in 1741); organization of three series of excavations on the site, the last sponsored by the official Mexican underwater exploration society (CEDAM), which resulted in the recovery of over 200,000 artifacts, Quintana Roo, Mexico, 1957 - 1959.
6. Discovery and identification of early Spanish wreck sites: La Nicolasa, supply ship of Hernan Cortes' expedition (sunk in 1526); and two snips burned and scuttled by Francisco de Montejo (1526), Quintana Roo, 1957.
7. Exploration of Caribbean waters off coasts of Central and South America, Leeward and Windward Islands and the Bahamas, with location of Spanish, French, English, Dutch and Portuguese wreck sites from period 1550-1800, 1960.
8. Underwater survey of submerged Roman cities of Carteya and Bolonia (southern Spain); location and exploration of wreck sites in Cadiz harbour and off Tarifa, Zahara, and Sanlucar de Barrameda, under auspices of the Museo Provincial de Cadiz, Spain, 1960-62.
9. Participation in archaeological excavation, sponsored by the Smithsonian Institution, of 16th century Spanish wreck site, Bermuda, August 1963.
10. Organization and direction of exploratory expeditions to Serrana, Seranilla, Roncador and Quitasueno Banks Isla Providencia (western Caribbean), which resulted in the location of a number of important Spanish colonial wreck sites and exploration of four of the principal sites, June-July, 1963 and May-November, 1965.
11. Direction of program of mapping and excavation of the sunken city of Port Royal, undertaken by the Institute of Jamaica, November 1965 - June 1968.
12. Discovery of two shipwrecks of Christopher Columbus which were lost in St. Anne's Bay, Jamaica, in 1504. Plans are underway to excavate these two shipwrecks in the near future. February 1968.

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13. Director of Research and Salvage operations for the Real Eight Co. Inc. of Melbourne, Florida. Summer months spent excavating various shipwrecks of a fleet which was lost in 1715 off the coast of Florida. The remainder of each year spent locating and salvaging ancient shipwrecks in the Bahamas, Mexico and Columbia. June 1968 - January 1971.
14. Archaeological survey on some ancient sunken walls and buildings off Bimini and Andros Island in the Bahamas. August 1969, July 1971 and December 1976.
15. Excavation of three Civil War blockade runners off Charleston and Sullivan Island, South Carolina. January - February 1970.
16. Archaeological explorations on land and underwater at various sites in the Yucatan Peninsula under the auspices of CEDAM of Mexico. January, April and May 1971 and February - March 1976.
17. Exploration for marine archaeological sites around nine different Caribbean Islands in the Windward and Leeward Island group under the auspices of the Minnesota Historical Society. February 1971.
18. Archaeological survey in Lake Toluca, Mexico for pre-Columbian artifacts under the auspices of CEDAM of Mexico. June 1971.
19. Underwater exploration for marine archaeological sites on both sides of the Isthmus of Panama under the auspices of the Panama Institute of Tourism. December 1971 - January 1972, April 1973 and March 1975.
20. Participation in exploration aboard the ALCOA SEAPROBE for ancient deep water wrecks off the coast of Florida. March and November 1972.
21. Exploration for an early 17th century Spanish shipwreck in 1800-2000 feet of water south of the Dry Tortuga Islands in the Gulf of Mexico using sonar and a TVSS (television search and salvage system). November 1972.
22. Exploration of the Little Bahama Bank using visual, sonar and Magnetometer methods in which a total of 21 shipwrecks were discovered, including the Nuestra Senora de la Maravilla, a Spanish galleon which sank in 1655. June - October 1972.
23. Exploration of the ancient Phoenician seaports of Byblos, Tyre and Sidon in Lebanon at the invitation of the Lebanese Dept. of Antiquities. During which survey for Phoenician shipwrecks dating from the 5th and 4th centuries B.C. (one with a cargo of terracotta figurines), two Greek shipwrecks from the 3rd and 2nd centuries B.C., two Roman shipwrecks from the 1st century B.C., and a Byzantine shipwreck from the 6th century A.D. were all discovered. Samplings of all cargoes of all the sites were collected for the Department of Antiquities. January and February 1973 and July 1974.

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24. Exploration around the Turks and Caicos Islands at the invitation of the Turks and Caicos Historical Society, to determine if one of these islands was the original landing place of Columbus on his first voyage. Eleven shipwrecks were also discovered, dating from the early 17th to the middle of the 19th century. November 1971, March 1973 and March 1977.
25. Exploration of waters surrounding Ascension Island in the South Atlantic at the invitation of the British Government in which four shipwrecks dating from the middle of the 16th century to the beginning of the 18th century were discovered and investigated. March 1973.
26. Magnetometer and visual search covering a 20 square mile area in the Florida Keys in which nine shipwrecks were discovered, explored and identified. May - October 1973.
27. Exploration of waters surrounding Grand Cayman Island at the invitation of the local government in which a number of shipwrecks were discovered. November 1973 and February 1978.
28. Exploration of a sunken city which was submerged in 1687 off Orangstaad, St. Eustatius Island in the Caribbean under the auspices of the Dutch Government. In addition to locating and mapping the visual submerged structures of the site, a number of old shipwrecks were also discovered and investigated. December 1973.
29. Participation in underwater archaeological surveys and excavations made along the northern coast of Israel under the direction of Mr. Elisha Linder of the University of Haifa. Most of the excavations were concentrated in the area of Acre on harbour works and a Crusader shipwreck. In this area and also at Athlit and Shavei Zion four Phoenician and several Hellenistic and Roman shipwrecks were located by a team lead by myself. September - October 1975 and May 1976.
30. Exploration of both the Atlantic and Pacific coasts of Panama under the auspices of the Panama Government. Very extensive visual and magnetometer searches were made around the Pearl Islands on the Pacific side of the Isthmus and on the Atlantic side around the mouth of the Chagres River, Porto Bello, Nombre de Dios and in the San Blas Islands. A total of 44 old shipwrecks pre dating 1800 were discovered. Test hole excavations were made on a number of the sites. June - November 1976 and February-July 1977.
31. Underwater exploration made in the waters off the Central American country of Belize. Seven virgin wreck sites were discovered and two proved to be 17th century Spanish Merchantmen. April 1976.

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32. At the invitation of the Australian Government, I explored four 17th and 18th century Dutch shipwrecks, plus others of other date periods and nationalities off the west coast of Australia. August-September 1977.
33. Underwater archaeological survey made at the invitation of the Dutch Antilles Government around the islands of St. Martin's, Saba and St. Eustatius. Wreck sites were discovered off each island and recommendations for their eventual excavation were made to the government. October - November 1977.
34. Search and excavation of numerous wrecks located in the Florida Keys between Marathon and Key Largo. Among the most important sites worked were three of the 1733 galleons, a 1622 merchantman and a French merchantman 1750. March - July 1978.
35. Extensive magnetometer and visual survey made off Cape Canaveral and surrounding waters. A number of shipwrecks were discovered but poor working conditions prevented them from being excavated. July - September 1978.
36. Aerial, visual and magnetometer of the Little Bahama Bank, covering some 40 square miles in which a total of 28 shipwrecks were located dating from the mid sixteenth to late 19th century. October 1978 and July - September 1979.
37. Working under the auspices of UNESCO and the Dept. of Education of the Mauritius Government, I conducted an extensive aerial and visual survey of the reefs surrounding this island, locating a total of 18 old shipwrecks which predate 1800; including four Portuguese East Indiamen of the 16th century and seven other East Indiamen (French, Dutch and English) of the 17th and 18th centuries. During this same expedition, I was a consultant to the team excavating the French merchant vessel St. Geran which was lost in 1744. A vast number of artifacts were recovered and after preservation, were placed on display in the island's Maritime Museum. February-April 1979.
38. Under the direction of the Naval Museum of Rio de Janeiro, I conducted an underwater visual survey in the waters surrounding Salvador (Bahia) and located 13 shipwrecks from the 17th, 18th and 19th centuries, including the flagship of the Dutch privateer, Piet Heyn, lost during his attack on that place in 1627. May 1979.
39. One Greek and two Roman amphora-carrying galleys were discovered in waters surrounding the port of Palma de Mallorca, Spain. In other areas, five large lead Roman anchors were discovered, which were not associated with a shipwreck. June 1979.
40. Underwater archaeological survey along the southern coast of Portugal in search of Classical period shipwrecks. In the harbour of Portimao, a Punic and a Roman shipwreck were discovered. October - November 1979.

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41. Underwater archaeological survey made in the Azores around the Islands of Sao Miguel and Santa Maria. Twelve different 16th to 18th century shipwrecks were surveyed. December 1979.
42. Extensive magnetometer and visual survey made along a thirty mile area of the southern and eastern shores of Cape Breton Island (Nova Scotia) Canada. More than 40 shipwrecks dating from the 17th to 20th century were discovered; amongst the most important were the British HMS Tilbury (1749) and an unknown section of the French warship Chameau (1725). Test excavations were made on the above two and several other 18th century shipwrecks. June - October 1980.
43. Under the direction of the Naval Museum of Rio de Janeiro, Brazil, two 17th century Dutch warships were partly excavated; the flagship of Piet Heyn (Hollandia) lost during his attack on the place in 1627 and the Utrecht lost in 1648. Both sites were located near the harbour of Salvador in the Bay of All Saints. The Portuguese East Indiaman, Santa Clara, lost in 1573 was also discovered 30 miles north of this Bay. November 1980 - March 1981.
44. Underwater archaeological survey made along the eastern and southern coast of Santiago Island in the Cape Verde Islands and seven 15th to 18th century shipwrecks were discovered; the two most important being two Portuguese merchantmen dating from the mid-16th century off the fishing village of Cidade Velha. On a beach on the Island of Sal remains of a Phoenician shipwreck dating from the 5th century B.C. was also discovered. May 1981.
45. Extensive magnetometer and visual survey made, covering an area of 150 square miles on the Great Bahama Bank, Bahamas with more than 50 shipwrecks dating from the 16th to 19th centuries being located. June - November 1981. April - October 1983, August - October 1984.
46. Aerial, sonar, magnetometer and visual search conducted along the coast, harbours and river mouths of the State of Pernambuco, Brazil, under the auspices of the Naval Museum of Rio de Janeiro, Brazil. Eighteen 16th to 19th century shipwrecks were discovered (Portuguese, Spanish, Dutch and French); the majority of which were 17th century ships lost during the Dutch occupation of this area. Two Dutch East Indiamen were also located. February - April 1982.
47. Under the auspices of the Musee de Marine (Paris) a sonar and magnetometer survey was conducted off the coast of Brittany, France, and nine 16th to 18th century shipwrecks were discovered, including three French warships from the famous Battle of Quiberon Bay (1759). Also participated in the excavation of the French warship Soleil Royal (1759) off Le Croisic. June - July 1982.

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48. Underwater archaeological survey conducted in Baia de Guanabara (Rio de Janeiro), Brazil under the auspices of the Naval Museum of Rio de Janeiro, on what is believed to be a possible Roman amphora carrier from the 2nd century B.C. Three other shipwrecks were found and surved on this site (16th, 17th and 20th centuries). September 1982 - February 1983.
49. Magnetometer and side-scan sonar survey and visual search conducted along the East Coast of Florida between Vero Beach and Cape Canaveral during which a number of shipwrecks from the 17th and 19th centuries were located. Several new sections of the flagship of the 1715 fleet, known as the "CABIN SITE" were located and excavated during the summer of 1985.

HISTORICAL RESEARCH

History of Spanish flotas and galleons, 1504-1776; European rivalry in the Caribbean, 1550-1825; Naval warfare, 1500-1825; shipwrecks from Cape Hatteras to Rio de la Plata, 1492-1825; pre-Columbian voyages to America; early history of diving and salvage.

- a. September 1959 - February 1960: Library of Congress, Academy of Franciscan History, Washington, D.C.; Hispanic Foundation, N.Y.
- b. February 1961 - July 1962: Archivo de la Indias, Seville; Archivo de los Duques de Medina-Sidonia, Sanlúcar de Barrameda; Museo Naval, Real Academia de la Historia, and Biblioteca Nacional, Madrid; Archivo Histórico de la Marina, Viso del Marques; Museo Naval, Barcelona; Vatican Archives, Vatican Library and Jesuit Historical Institute, Rome.
- c. September 1963 - March 1964: Museo Naval, Madrid; Archivo de Simancas, Simancas; Arquivo Historico de Ultramar; Arquivo Nacional da Torre do Tombo, Lisbon; Museu da Marinha, Belem; Library of the University of Coimbra, Coimbra; Osterreichische Nationalbibliothek, Vienna; Bibliotheque Nationale and Musee de la Marine, Paris.
- d. May 1964 - April 1965, June 1981 and March 1982: British Museum, Lloyd's of London, Public Record Office, London; National Maritime Museum, Greenwich; Nederlandisch Historisch Scheepvaart Museum, Amsterdam; Netherlands Royal Archives, The Hague.
- e. August - September 1968: British Museum; National Maritime Museum; Museo Naval, Madrid.
- f. July 1969: Archivo de Simancas, Simancas, Spain.

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- g. August - October 1971: British Museum, Lloyd's of London, London; Museo Naval Biblioteca Nacional, Madrid; Archivo de las Indias, Seville.
- h. May - June 1975, April 1951 and December 1981: Archivo de las Indias, Seville; British Museum, London; Public Records Office, London.
- i. September - October 1977, November 1978 and January 1979: Archivo de las Indias, Seville.
- j. November - December 1978 and August 1982: Biblioteque Nationale, Paris.
- k. March - April 1983: Netherlands Royal Archives, The Hague; Public Records Office and the British Library, London.
- l. November - December 1983, February - March 1984, November - December 1984 and February - March 1985: Archivo de las Indias, Seville; Museo Naval, Madrid; Musee de la Marine, Paris.

VOYAGES

Co-organizer and navigator; voyage of Nina II, replica of Columbus' caravel, from Palos, Spain to San Salvador, August - December 1962. Was made a Knight Commander in the Order of Isabel the Catholic by the Spanish Government as a result of making this voyage.

Organizer and captain, voyage of replica of 10th century Gokstad Viking ship (projected voyage from Gibraltar to Yucatan to demonstrate possibility of pre-Columbian voyages in open-decked, square-rigged vessels; shakedown cruise, Rijeka, Yugoslavia to Bizerta, Tunisia, where shipwrecked in a storm. - March - April 1964.

Organizer and captain, voyage of a replica of 10th century Gokstad Viking ship for the same purpose as previous voyage in 1964. Voyage started in Limerick, Ireland, and ended 4,400 miles later at Gibraltar. April - June 1969.

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OTHER EMPLOYMENT

International Minerals and chemicals Corporation (Skokie, Illinois),
Oceanographic Consultant, December 1959 - December 1960.

Saturday Evening Post, Adventure Editor, January - September 1963.

Argosy Magazine, Archaeology Editor, December 1967 - December 1978.

Dive magazine, Contributing Editor, January 1965 - August 1974.

Real Eight Company Inc., Director of research and salvage, June 1968 -
January 1971.

Seafinders, Inc., Vice President, May 1971 - May 1974.

Ocean Industry Insurers Ltd. (London), Consultant on deep diving
systems and submersibles, October 1971.

Scripps Institution of Oceanography, visiting Lecturer in underwater
archaeology, January - February 1974.

Sea World Enterprises, Inc., President, August 1974 - June 1976.

Planet Ocean (International Oceanographic Foundation), Consultant,
October 1974.

Aquarius Magazine, Contributing Editor, 1972 - 1976.

University of California at San Diego, visiting Lecturer in underwater
archaeology, January - March 1974 and February 1975.

L.O.S.T. Inc., Expedition Leader, February - October 1978.

Phoenician Explorations, Director of Operations, January 1979 to
present.

PUBLICATIONS

Over 400 scientific reports, popular articles and reports.

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ORGANIZATIONS

- Escuela de Estudios H/spano-Americano, Seville, 1962.
- Council of Underwater Archaeology, San Francisco, 1963.
- Academia Real de la Historia, Madrid, 1963.
- Club de Exploraciones Deportivas Acuaticas de Mexico (CEDAM), Mexico City, 1959.
- CEDAM International, Washington, D.C. 1963.
- Caribbean Research Institute, St. Thomas, Virgin Islands, 1967.
- Instituto del Caribe, University of Puerto Rico, 1964.
- The International Oceanographic Foundation, Miami, 1964.
- American Institute of Nautical Archaeology, Cyprus, 1973.
- American Littoral Society, Sandy Hook, New Jersey, 1974.
- National Maritime Historical Society, New York, 1971.
- Jamaican Historical Society, Kingston, 1965.
- Society for Nautical Research, Greenwich, England, 1958.
- Explorer's Club, New York, 1959.
- Adventurer's Club, Los Angeles, 1972.
- American Scandinavian Foundation, New York, 1963.
- Underwater Society of America, Philadelphia, 1960.
- Society for Historical Archaeology, Washington, D.C. 1971.
- Sea Research Society, Mount Pleasant, South Carolina, 1972.
- Underwater Exploration Society of Israel, 1975.
- Save the Dolphin Foundation, San Francisco, 1975.
- The Epigraphic Society (elected as a Fellow in 1982), San Diego.
- Groupe Pour Le Recherche et L'Inventaire des Epaves, Paris, 1978.

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BOOKS

- Historia de la Isla de Cozumel, Merida, Yucatan, 1959.
Voyage of the Niña II, World Publications Co. Cleveland-New York 1963.
Following Columbus, World, 1964 (Juvenile).
The Battle of the Armada, 1588, World 1965 (juvenile).
The Battle of Lepanto, 1571, World, 1965 (juvenile).
They Dared the Deep: A History of Diving. World, 1967.
History of the Sunken City of Port Royal, World, 1967.
Always Another Adventure, World, 1967.
Treasure Fleets of the Spanish Main, World, 1968.
Shipwrecks in Florida Waters, Real Eight Co. Inc., 1969.
Shipwrecks in Mexican Waters, CEDAM, Mexico City, 1971.
Shipwrecks of the Western Hemisphere, World, 1971.
Sea Fever: Famous Underwater Explorers, Doubleday, 1972.
Port Royal Rediscovered, Doubleday, 1973.
The Lure of Sunken Treasure, David McKay, 1973.
Underwater Dig: Manual of Underwater Archaeology. David McKay, 1975.
Shipwrecks of the Western Hemisphere (New Revised Edition), David McKay, 1975.
Secrets Beneath the Sea, Belmont-Tower, 1975.
Capture of the Spanish Plate Fleet: 1628, David McKay, 1976.
Diving for Adventure, David McKay, 1979.
Spanish Treasures in Florida Waters, Mariner Press, Boston, 1978.
Still More Adventures, Mason Charter, 1976.
Buried Treasures of the United States, David McKay, 1978.
Into the Deep: A History of Man's Underwater Explorations. Van Nostrand Reinhold, 1978.
Quest for Treasure (Discovery of the galleon Maravillas). Ram Publishing Co., Dallas, Texas, 1982.

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BOOKS TO BE PUBLISHED

Gold: From the Dawn of Time to the Fall of Rome, with Jenifer Marx.
Gold: From the Fall of the Roman Empire to the Present, with
Jenifer Marx.
Buried Treasures of the Spanish Main. David McKay.
Pre-Columbian Voyages to America.
Pirates, Privateers & Buccaneers of the Spanish Main, with Jenifer Marx.

MOVIES

Over a period of some twenty odd years I have been involved in the filming or production end of over 30 documentary films, the majority of which were shown on nationwide television. Among the most important films was "The Adventurous Voyage of the Nina" which was a two hour film on CBS-TV shown in February 1963, "Viking Voyage" shown on NBC-TV as a one hour special in August 1964, and "Treasure Galleon" narrated by Rod Sterling and shown on nationwide television as a two hour movie during 1975 and 1976. Most recent films made were "Indian Ocean Treasure" in 1981 and "The Battle of Quiberon Bay" made for both French and American television in 1982.

LECTURES

I have lectured professionally for more than ten years throughout the United States and in more than ten foreign countries on the subjects of underwater archaeology, maritime history, treasure hunting and travel.

LANGUAGES

Speaking: English and Spanish.
Reading: Spanish (including old Spanish), Italian, Portuguese and French.

DR. JEAN - YVES BLOT

Age: 34
Citizenship: French

Dr. Jean-Yves Blot is a recognized underwater archaeologist and has his doctorate degree in underwater archaeology from the Sorbonne in Paris and also has a masters degree in anthropology. Mr. Blot has been diving on shipwrecks as his main employment since 1970 and has participated in or led underwater archaeological expeditions off Iceland, France, Portugal, Kenya, Madeira, Mauritania, Mauritius Island, the Bahamas and Florida. Among his notable finds are the French East Indiaman Saint Geran, lost in 1744 off Mauritius Island in the Indian Ocean; the Meduse, lost in 1807 off Mauritania; and the Soleil Royal, lost in 1759 off the coast of Quiberon, France. Mr. Blot is the author of two books dealing with his work on shipwrecks, has four major documentary films and has lectured extensively throughout Europe and the United States. Currently he is employed as an underwater archaeologist for the Museum of Archaeology in Belem, Portugal.

DR. MARIA-LUISA DE BRITO PINHEIRO BLOT

Age: 38
Citizenship: Portuguese

Dr. Maria-Luisa De Brito Pinheiro Blot has her doctorate degree in history from the University of Coimbra in Portugal. She has spent a number of years doing archival research relevant to shipwrecks in all of the major depositories of Europe, the United States, India and Indonesia. In addition to being a historian, she is a diver and underwater archaeologist and has participated in all of the expeditions of her husband, Jean-Yves Blot. She has written many articles and is an expert still photographer. Both she and her husband have worked in numerous countries with Mr. Robert Marx during the past 10 years. Currently she is employed as an underwater archaeologist for the Museum of Archaeology in Belem, Portugal.

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CURRICULUM VITAE

Nicholas P. Cushner

Date and Place of Birth: December 6, 1932 New York City

Academic Achievement: Ph.D. University of London, University College,
1968, Latin American History

Teaching Specialization: Social History of Colonial Latin America

Courses taught:

Colonial Latin America
Modern Latin America
Modern Mexico
Literature and Society in Latin America
Western Civilization
Social Effects of Colonization:: Latin America and the
Philippines Compared
Land and Society in Colonial Peru (Grad.)
Spanish American Paleography (Grad.)

Research Specialization: Social effects of land tenure patterns in colonial
Latin America

Academic Experience:

1968-1970. Asst. Prof. of History, Ateneo de Manila
University, Manila, Philippines

1970-1974. Asst. Prof. of History, Canisius College,
Buffalo, N.Y.

1974-1975. Visiting Research Scholar (with teaching) in
History, State University of New York at Buffalo

1975-1977. Asst. Prof., Empire State College, State
University of New York

1977-¹⁹⁸⁶Present. Assoc. Prof., Empire State College (Buffalo);
tenured 1980

1979-Present. Adjunct Professor of History, Dept. of
History, State University of New York at Buffalo

Other Positions: New York State Education Department, Member of Selection
Committee for New York Regents Fellowships for Doctoral
Study, 1971-

State University of New York, University Awards Committee,
Chairperson for Non-Western History, 1978- Awards/Honors:
1979 Empire State College (SUNY) Faculty Lectureship
Award for significant scholarly achievements

* 1986 - Full Professor
SUNY

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1981-1982. President of the New York State Latin Americanists

1984-198 . Selected and appointed by Chancellor as SUNY Distinguished Lecturer

Membership in Professional Organizations:

Fellow of the Royal Historical Society, elected May 13, 1968
Conference of Latin American History
Latin American Studies Association
New York State Latin Americanists (President, 1981-1982)

Grants Received after 1976:

1978. SUNY, University Awards Program, \$2800 for research in Quito, Ecuador
1980. Andrew W. Mellon Foundation Fellowship, \$1800 for research in microfilm collection in St. Louis University Vatican Library section
1981. SUNY, University Awards Program, \$3000 for research in Lima, Peru
1983. Fulbright Award for Research in Peru
1983. National Endowment for the Humanities Summer Stipend Award, for research in Peru

Publications

BOOKS

Jesuit Ranches and the Agrarian Development of Colonial Argentina, 1650-1767.
Albany: SUNY Press, 1983.

Farm and Factory. The Jesuits and the Development of Agrarian Capitalism in Colonial Quito, 1600-1767. Albany: SUNY Press, 1982.

Lords of the Land. Sugar, Wine, and Jesuit Estates of Coastal Peru, 1600-1767.
Albany: SUNY Press, 1980.

Landed Estates in the Colonial Philippines. New Haven: Yale Univ. Southeast

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Asian Studies, 1976.

Spain in the Philippines. From Conquest to Revolution. Manila: Ateneo de Manila Univ. Press, 1971.

Documents Illustrating the British Conquest of Manila, 1761-1764. London: Royal Historical Society, 1971.

Islands of the West. Early Spanish Voyages to the Philippines. Manila 1973

Select Articles

"Slave Mortality and Reproduction on Jesuit Haciendas in Colonial Peru." Hispanic American Historical Review, May, 1976, 177-99.

"Meysapan: The Formation and Society Effects of a Landed Estate in the Colonial Philippines," Journal of Asian History, July, 1973, 30-53.

"Merchants and Missionaries," Hispanic American Historical Review, August, 1967, 360-69.

Reviews

Since 1971 I have been a regular reviewer for the Hispanic American Historical Review, the Journal of Asian Studies, and reviews of mine have also appeared in the Times Literary Supplement (London), Bulletin of Hispanic Studies, Indice Historico Espanol, and Philippine Studies.

Addresses:

Home - 344 Ashland Ave., Buffalo, New York 14222
(716) 882-1453

Office - 564 Franklin Street (Empire State College)
Buffalo, New York 14202 (716-886-8020)

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JENIFER G. MARX

Date of Birth: 1 May 1940

Present Address: 330 Thyme Street,
Satellite Beach, Florida 32937

Telephone: 305-777-2061

Jenifer G. Marx is a historical writer and the wife and associate of Robert Marx in his underwater archaeology projects. A graduate of Mount Holyoke College with a B.A. in 1961, she also studied at the University of Florence in Italy. Mrs. Marx was a member of the first U.S. Peace Corps contingent in the Philippines. She taught in Negros Oriental and also worked at the University of the Philippines in Manila. In 1962, she was appointed volunteer leader and travelled throughout the archipelago as liaison between the Peace Corps and local governments. She was involved in establishing the National Peace Corps Training Center near Zamboanga on Mindanao. Subsequently, Mrs. Marx was associated with the International Labor Organization in Africa, Jamaica and Indonesia. She began diving in the Philippines in 1961 and since 1966 has worked with Mr. Robert Marx as a diver and archival researcher in Jamaica, Mexico, Indonesia, the Bahamas, Florida, Brazil, Panama, France, Portugal, England, Ireland, Canada and the Caribbean. Mrs. Marx is the author of several books and many articles on topics ranging from the history of gold to maritime and colonial history.

IAN D. SPOONER

Address: Church Cottage, St. Clement
Cornwall, England TR1 1SZ

Citizenship: British

ACADEMIC QUALIFICATIONS

- 1964 - 1966 Diploma in Estate Management and Surveying.
- 1968 - 1971 Bachelor's Degree in Architecture.
- 1980 - 1981 Post-Graduate Diploma in Maritime Archaeology, with distinction.

QUALIFICATIONS RELEVANT TO MARITIME ARCHAEOLOGY

- 1951 Scuba Diving NQS/CMAS 2 Star.
Australian Cave Diving Federation Class 2.
HSE (British Government) Part 4 (Commerical) Diving Management Certificate.
Re-compression Chamber Operator's Certificate.
Royal Institute Chartered Survey, Royal Institute of British Architecture, professional exemptions.

COURSES ATTENDED

- 1957 Surrey Archaeological Society.
Archaeological Appreciation and Field Techniques.
- 1963 Cirencester Summer Archaeological School (six weeks excavation of a Saxon site).
- 1964 Prehistoric Archaeology Field School, Warminster.
- 1966 Voluntary Service Overseas Farnham Castle Management for Overseas's Professional Appointees.
- 1977 Young Men's Christian Association of New Zealand Management and Financial Courses.
- 1978 P.A. New Enterprise Course, OXFAM Resource Management, Personnel Management and Financial Management Courses.

PROFESSIONAL ACTIVITIES IN MARITIME ARCHAEOLOGY

1. Committee member and Projects Officer for Nautical Archaeology Society of Britain.
2. Committee member and representative from Victoria, Australia for Australian Institute of Maritime Archaeology.
3. West of England Maritime Museum.

PROFESSIONAL PUBLICATIONS IN MARITIME ARCHAEOLOGY

1. "Some Notes on an Old Topic...Boat and Ship Building Methods of the Far East" Indonesia Journal; Spooner, 1975.
2. "A Report of the 1980 Excavation of 'The Hadda' Wrecksite in the Houtman Abrolhos" (Directed by I. Spooner and L. Vickery) Spooner and Vickery; AIMA Bulletin No. 4.
3. "Classical Mediterranean Shipbuilding" Western Australian Museum Publications, 1980.
4. "Field Conservation for Remote Wrecksites" Spooner, AIMA Bulletin No. 5.
5. "The William Salthouse - A Preliminary Report" AIMA Bulletin No. 6.
6. "The William Salthouse" (Directed by I. Spooner, State Maritime Archaeologist, Victoria, Australia) Spooner, Staniforth and Vickery; AIMA Bulletin (in preparation).
7. "The Underwater Cultural Heritage", I. Spooner, 1983.

PAPERS PRESENTED AT MARITIME ARCHAEOLOGICAL CONFERENCES

1. University of Western Australia, 1980; Boatbuilding Technology in the Far East and in the European Bronze Age Period: a comparison.
2. Dartington Conference on Maritime Archaeology 1982: A Maritime Museum for the South-West.
3. British Nautical Archaeology Symposium 1982: Latest Developments in Maritime Archaeology in Australia.
4. The Maritime Heritage: OCEANS 1983, Australia (N.A.S. Conference).
5. Nautical Archaeology Society Conference 1984: Government Participation and Support for Maritime Archaeology.

RESEARCH IN MARITIME ARCHAEOLOGY AND MARITIME HISTORY

1. Survey and recording of Thames Barge building yards and barge hulks, Yantlet Creek, Essex. 1957.
2. Restoration of traditional Thames one-design yacht. 1958.
3. Voyages with Tristan Jones (Royal Geographical Society), assistant with his researches into early Celtic Seafaring. 1962.

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4. Study of West African ship and boat building techniques and underwater search for German submarine in the Gambia River. 1966-1968.
5. Study of Indonesian ship and boat building techniques from prehistoric times to the present day including building a traditional Bugis Pinisi and the restoration and recording of an Indonesian Sekoci for the Western Australian Maritime Museum. 1971-1981.
6. Organization with local government authorities and in collaboration with the National Maritime Museum of a program for the recording of sites of archaeological interest in the inter-tidal zone around Britain's coast. 1983-1984.

RESEARCH IN TERRESTRIAL ARCHAEOLOGY

1. Survey and recording of unidentified stone circles in The Gambia. 1966-1968.
2. Expedition to the Tassili and Ahaggar regions of the Sahara for a photographic study of the cave paintings and in the search for the remaining cedar trees (subsequently discovered). 1968.
3. Salamis, Cyprus: Investigation of the remains of the city land site in the shallow waters offshore. 1969.
4. Kyrenia, Cyprus: Observation of the excavation of the 400 B.C. shipwreck site. 1969.
5. Investigation of several prehistoric Donsong sites in Eastern Indonesia. Location of several previously unknown Hindu sites in the eastern islands. Collection of ethno-archaeological material and the establishment of a Museum in Timor and a museum collection in the island of Rote. 1971-1982.

DIRECTION OF MARITIME ARCHAEOLOGICAL EXPEDITIONS

1. The Hadda, Houtman Abrolhos. An expedition to locate, excavate and record the remains of a 19th century ship. 1980.
2. The St. Anthony, Cornwall (continuing); survey and excavation of a 1527 wreck of a Portuguese Carrack owned by the King of Portugal. 1981.
3. The Schiedam, Cornwall (continuing); survey and excavation of a 1676 ship wreck of a Dutch fly-boat captured by the British at Tanger. 1981.
4. The Ccotamundra Shoals Survey, Arafura Sea-Timor. Deputy leader and chief diver of a major expedition to the Timor Sea to investigate prehistoric and geomorphological surveys. British Sub-Aqua Club Expedition Award. Diving to 60 meters. Patron, His Royal Highness, Prince Charles. 1982.

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5. The Loch Ard, Victoria, Australia. Rescue and recording of artifacts from the exposed site of an 1871 wrecksite. 1983.
6. The William Salthouse, Victoria, Australia. A major excavation of the first direct cargo shipment from Canada to Australia, wrecked in 1841. 1983.
7. The t'Vliegenschart, North Sea, Holland (in progress). Excavating the wrecksite of an 18th century outward bound East Indiaman. 1984.
8. Engaged in excavating various wrecks of many nationalities in the Goodwin Sands area of the English Channel. 1984 to present.

MARITIME ARCHAEOLOGICAL CONSULTATION

Devon Education Authority.

Maritime archaeology taught in secondary schools in England, for the years 1984/85/86.

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MARK H. WULF

Address: 199 Tyler, Apt. 17
Cape Canaveral, Florida 32920

Date of Birth: July 30, 1953, Bay shore, Long Island, New York USA

EDUCATION

U.S. Navy Engineman Class A, Great Lakes, Illinois 1971.
U.S. Navy Deep Sea Diving School, Key West, Florida 1972.
Correspondence Courses in Oceanography, Advance Salvage and Deep
Diving Techniques 1973 - 1974.
RCA Management Seminar November 1979.

PROFESSIONAL EXPERIENCE

- 1971 - 1975 Spent four years active duty in the United States Navy,
honorably discharged. Primary duties as a diver aboard
a submarine tender engaged in underwater maintenance and
and repairs on nuclear powered submarines; also the
operation and maintenance of a 55 foot diving support boat.
- 1975 - 1975 Worked on various short term jobs such as diving, marine
mechanic work and commercial fishing. Company names and
locations furnished upon request.
- 1976 - 1981 RCA Atlantic Undersea Testing and Evaluation Center, Andros
Islands, Bahamas. Position was Diving Superintendent in
complete charge of eight divers with responsibilities which
included equipment inventory, research and planning for all
diving operations from start to finish; a recompression
chamber with crew available 24 hours; also the setting up
of both training and maintenance programs, semi annual
employee evaluations, and annual budgeting for materials
and operating cost. Diving work consisted of inspection,
maintenance, installation, and repair of all underwater
equipment - i.e. electronic arrays, offshore towers, cable
laying, research and development projects, recompression
chamber operations, and maintaining a fleet of range
support vessels ranging in size from 30 to 200 feet.

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- 1981 - 1985 Master diver for Circle Bar Salvage Company, a Florida based firm engaged in the discovery and excavation of old shipwrecks in Florida and the Bahamas. Also experienced in operation of sonar, magnetometers and other detection equipment. I also have a United States Coast Guard 100 ton Ocean Captain's license.
- 1986 My most recent diving experience has been as a civilian contract diver employed by the National Aeronautics and Space Administration (NASA) of the United States to recover wreckage from the Challenger space shuttle disaster.

SUMMARY

I have twelve years diversified marine construction experience including commercial diving, rigging, welding, cutting and masonry and carpentry work, diesel mechanics, heavy equipment operation and high seas operations as both a seaman and ship captain. During this same period I participated in numerous commercial salvage operations such as raising modern fishing vessels. During the past five years my work has been in the field of underwater archaeology and commercial salvaging.

LETTERS OF COMMENDATION AND APPRECIATION FROM MAJOR COMPANIES AND THE UNITED STATES GOVERNMENT FOR DIVING OPERATIONS AND LIFE SAVING ACTS, FURNISHED UPON REQUEST.

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JAMES E. HILL, JR.

Age: 46

James E. Hill, Jr. has been a diving supervisor with the John W. Mecom Company in Florida and the Bahamas since April of 1983. In this capacity, Mr. Hill has worked under the direction of Mr. Robert Marx during 1983 through 1985 searching for specific sunken ships. Prior to his employment with the Mecom Company, Mr. Hill worked for McDermott International as a supervisor on a barge offshore the Brazilian coast laying pipelines. Prior to this, he was the lead diver and supervisor on McDermott Jet Barge II for Ocean Systems Do Brazil out of Rio de Janeiro. In this capacity, he supervised and inspected underwater pipeline construction. Mr. Hill has also been employed supervising bounce and saturation dives of up to 1,000 feet for drilling support. He has a Bachelor of Business Administration degree from the University of Texas. He has also attended the School of Drilling Practices at the University of Southern Louisiana, and taken courses in underwater photography at the Brooks Institute in Santa Barbara, California, and commercial diving at the Commercial Diving Center in Wilmington, California.

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Dr. Harold E. Edgerton

In one way or another, the inventions of Dr. Harold E. Edgerton touch our lives daily. His perfection of the stroboscope in 1930 produced ultra-high speed photography; today, the strobe and his other discoveries are indispensable in many areas of science, medicine, and industry.

Since 1936, awards and citations have recognized his unique talents and eagerness to share his discoveries with colleagues and thousands of students at Massachusetts Institute of Technology where he taught for more than fifty years. Now MIT Professor Emeritus, Dr. Edgerton continues to shape the lives of eager young students.

Childhood interest and experience "on the job" in an electrical plant in his hometown, Aurora, Nebraska, preceded Dr. Edgerton's studies at the University of Nebraska and MIT. His arrival in 1926 as a graduate student presaged a new era in electrical engineering research.

In the 1930s, his strobe was adapted for nighttime reconnaissance by the U.S. Air Force, enabling round-the-clock air photo surveillance of enemy forces in World War II. Later, Dr. Edgerton and his two former students, Kenneth Germeshausen and Herbert E. Grier, developed equipment to film nuclear experiments. This partnership was the forerunner of EG&G.

Dr. Edgerton's pioneering research produced outstanding achievements in the development of underwater cameras, lights, and special sonars. He and Jacques-Yves Cousteau collaborated on unmanned deep-sea cameras which were used in searches for the Loch Ness monster and the battleship *Monitor*, two adventures in which "Doc" was involved. The search for the *Monitor* was the subject of a feature article in the January 1975 issue of *National Geographic*.

While his genius continues to break barriers in research, Dr. Edgerton gathers new friends and colleagues in the diverse fields of oceanography, nautical archaeology, and art.

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APPENDIX C



10 September 1985

Mr. Robert Marx, Director
Phoenician Explorations
330 Thyme Street
Satellite Beach, Florida 32937

Dear Bob,

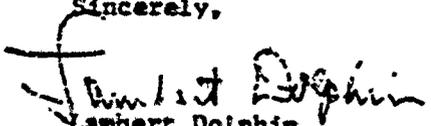
Enclosed is our renewed proposal, as per your request.

The price of this proposal is significantly higher than quoted in our previous proposal. Only a small part of this increase is due to salary changes and other annual cost changes. We all felt we wanted to increase our level of effort in development work and testing to build a much better instrument and do the best possible job we can. Technically what we propose to do is very difficult and we feel we should devote extra effort to the task.

Actual testing on site in the Bahamas has not been included as part of this present proposal; we suggest that you or one of your associates join us here in Menlo Park during our final testing before delivery. We also suggest that a follow-on contract would be appropriate in order to permit two members of our staff to accompany you during your next season's work, to gain experience in the use of this instrument. This will help us to build improved models and to add later refinements increasing the utility and cost-effectiveness of the instrument. We believe this will make it a marketable item others will wish to purchase and use for their own applications.

We greatly appreciate your interest and are anxious to do a good job for you.

Sincerely,


Lambert Dolphin
Assistant Director
Radio Physics Laboratory

pdy

Enclosure

SRI International

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10 September 1985

Phoenix Explorations
330 Thyme Street
Satellite Beach, Florida 32937

Attn: Robert F. Marx, Director

Re: SRI International Proposal for Research No. ESC 85-179
"SENSITIVE METAL DETECTOR FOR LOCATING DEEPLY BURIED ARTIFACTS"

Dear Mr. Marx:

In December of 1983 you explained to me in a telephone conversation the practical problems frequently encountered in galleon salvage operations in the Bahamas. You indicated that wrecks were frequently scattered over large areas, and that sand depth over the sites could be as much as 20 to 25 ft. We discussed various metal-locator schemes and their limitations at that time and agreed on the various equipment now available. Your letter of reminder of 10 July 1984 stimulated us to look at both current and innovative equipment design to see if we could make a major improvement in locating underwater small, nonmagnetic metal objects (base, silver, bronze, and the like).

In my letter of 17 July 1984, I mentioned that Bill Edson and Roger Vickers, both of our Laboratory, recommended a large horizontal loop to increase the depth of detection capability of a metal detector. As you know, most metal detectors are intended for coin-shooting on land or in shallow water. The market is competitive: the price must be kept down and the units need to be light weight and easy to use. The search coil diameter is usually 8 to 12 in., and the power output is a few watts. A few "large coil (approximately 3-ft diameter), deep search" detectors have been manufactured, but as you pointed in our first telephone conversation, no one has been able to achieve more than 6 to 8 ft of useful penetration. (For example, the "Gemini II Deep-Search" metal detector by Fisher Research Laboratory has an advertised sensitivity of 3 ft for a jar of coins, 5 ft for a one-inch diameter pipe, 10 ft for a large metal chest, and 20 ft for a "mineral deposit.") The sensitivity of a loop-type metal detector decreases inversely as the sixth power of the distance from the coil; this means that doubling the distance from the coil decreases the instrument sensitivity by a factor of 64. Increasing the transmitted power in a given system is thus not nearly as

SRI International

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helpful as increasing the loop diameter, and this is why we suggested coil size of 25 to 30 ft in diameter. No matter how much we increase the power or are clever with our use of circuitry, we shall not in practice succeed in locating small objects buried 20 to 25 ft in sand without a large coil.

As we explained in our proposal, SRI Proposal ESC 84-197, to you last year, a good summary analysis of metal detectors, radars, seismic sounders, magnetometers, resistivity methods, and electromagnetic detectors has been written by J. Jeffrey van Ee of the Advanced Monitoring Systems Division, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada, as part of their 1983 government study "Geophysical Techniques for Sensing Buried Wastes and Waste Migration". Their recent study of the limitations of metal detectors as well as other methods is in substantial agreement with our own experience, as yours.

My colleagues Bill Edson, Roger Vickers, and I have had several good discussions to complement the mathematical analysis Joseph Mosni did for us a year ago recommending coil configurations and calculating the sensitivity of a large, horizontal-loop metal detector. One advantage in working in sea water is that noise signals from the surf will not be detected by the system, and thus a very sensitive receiver may be used. A large loop also covers much area per pass, lessening time required to search a large wreck site. Though very large, the loop can be lightweight and designed for ease of towing from a hydrodynamic point of view. We also suggested and still recommend equipping the system with a small bottom-finding sonar so that the detector unit can be "flown" a few feet above the sea floor.

Our calculations indicate that we can expect a detector with a 20-ft coil diameter to be capable of detecting a single gold bar at a depth of 20 to 25 ft. Originally, we thought in terms of one transmitting coil and a large number of receiving coils, but further analysis has shown us that we can do just as well with a few coils. Solid-state components now allow us to build a very sensitive and very small receiver, and we suggest a moderately high-powered transmitter (several kilowatts), which is also now readily available.

We would like to hereby renew last year's proposal in response to your phone call on 28 August. Our basic technical approach has not substantially changed since last year's proposal, so we feel we stand good chance of being able to deliver a working large-scale very sensitive metal detector in time for your summer 1986 diving season, provided we can start work in the next 30 to 60 days. As before, we propose to build a developmental model of the detector for ocean testing (locally) for design optimization. After testing, we would then be prepared to build a more rugged, durable version, incorporating changes that prove to be desirable as a result of the testing. Because the instrument will follow an entirely new design, our research progress will be kept proprietary.

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We propose on a best-effort basis to design and construct a working model of the new detector system eight (8) months after the start of work. The system would include the following:

- (1) Towable, hydrodynamically designed coil package, pressure designed and waterproof, equipped with built-in sonar depth finder and guide fins. Approximate diameter 25 ft.
- (2) Supporting electronics and power supply including generator, transmitter, receiver and display unit with both real-time and recorded data collection. (Various data collection schemes are possible.)
- (3) All necessary cable, hardware, and the like.
- (4) Detailed operating manual.

The objective would be to produce sensitivity which would allow detection of a metal object presenting a cross-section of approximately ten (10) square inches at depths of 20 to 25 ft.

Actual testing on site in the Bahamas has not been included as part of this present effort; we suggest that you or one of your associates join us here in Menlo Park during our final testing before delivery.

Total cost of the work as outlined will be \$195,000. Our development and building of the proposed detecting system will require an immediate expenditure of funds, and it is our policy on this type of commercial contract to receive an advance payment before commencing work and a letter of credit for the balance. A down payment of \$100,000 (plus a letter of credit for the balance) accompanying one copy of the enclosed signed agreement is all we need to commence work on this project. The second copy of the agreement is for your record.

Because of the experimental nature of this development work, SRI cannot guarantee that we will be successful in producing a detector that will meet your specifications. Therefore, we will only do the work on a best efforts basis.

To discuss technical matters, specifications, and test and delivery schedules, please contact me at (415) 859-4868. Questions concerning contractual matters may be addressed to Barbara Camph at (415) 859-4328. This proposal as priced remains in effect until 31 December 1985. Please contact me should you wish an extension.