

physical and biological oceanography data, including information on a range of trophic levels from the lowest (phytoplankton) to the highest (top predators), and as many species within each trophic level as possible. NOAA Fisheries also solicited the opinions from members of a separate Ecosystems Panel, comprised of independent scientific experts in biological oceanography and ecology.

Available scientific information reveals the existence of periodic, low frequency changes within the ETP. These longer, decadal-changes are evident from sea surface temperature data beginning in 1901. Notably, a shift occurred in the late 1970s that was detected throughout the Pacific Ocean. Changes at that time in the physical environment and in biological communities were clearly documented in the North Pacific Ocean. In the ETP, this shift resulted in a warming of less than 1°C. Coincident with increase in temperature in the ETP, there was a weakening of trade winds and a small change in surface chlorophyll. No other responses to this late 1970s shift have been reported, but biological data prior to 1976 are sparse or currently unavailable in a form that would allow comparisons with more recent data.

In addition to periodic, low-frequency ecosystem changes, the ETP ecosystem is periodically affected by the El Nino/Southern Oscillation (ENSO), which occurs on two to seven year periods. All investigations by NOAA Fisheries indicated that variability associated with ENSO events is the predominant variability throughout the ecosystem, having a much greater effect than periodic decadal-scale changes. These ecosystem changes are in part supported by analyses of data on prey fishes, squids, and seabirds collected by NOAA Fisheries during dolphin surveys since 1986. The broader significance of these changes, however, is limited given the absence of comparable data prior to the early 1980s.

NOAA Fisheries' research indicates that dramatic reductions in carrying capacity caused by ecosystem changes is considered unlikely. If an ecosystem change dramatic enough to impact dolphin stocks had occurred, it is unlikely that the only animals affected would be dolphins. Data on a wide range of habitat variables and species were collected, beginning in 1986, as part of the NOAA Fisheries dolphin assessment cruises. No dramatic shifts were detected. However, NOAA's ability to determine existence and magnitude of ecosystem changes in the ETP, together with the effect of those changes upon depleted stocks, is significantly

limited by a paucity of relevant scientific information. Questions remain as to the actual carrying capacity of depleted stocks under even optimal conditions. Additionally, there are few data available concerning the ETP ecosystem prior to the late 1970s, hindering the ability to examine low frequency ecosystem changes and their effect on depleted marine mammal stocks. Assessments are further limited by the possibility that even small changes in background physical conditions can have large effects upon species within that ecosystem.

The potential effect of ecosystem changes was addressed by the five members of the Ecosystem Panel, each of whom had significantly different expertise to bring to bear on their individual opinions. The Ecosystem Expert Panel members' assessments were based on their review of the NOAA Fisheries Final Science Report, and relevant oceanographic and ecosystem data from the period of the fishery.

All experts agreed that historical surface temperature data indicate that since the mid 1970s, the Pacific Ocean has been in a warm phase of the Pacific Decadal Oscillation (PDO). Within the ETP, this PDO cycle has resulted in a surface temperature increase of 2 degrees centigrade above temperatures documented during a cold phase which occurred in the 1950s and 1960s. (Report of Michael Landry). While increased temperatures may result in some positive effects, most experts agreed that temperature increases would result in a deeper thermocline, which in turn would reduce the availability of prey species for depleted marine mammals.

In addition to ecological changes brought on by PDO, experts also noted environmental changes attributable to ENSO. Like PDO, changes associated with ENSO result in increased surface water temperatures. Evidence indicates that prey fish are substantially depressed during ENSO. (Reports of Read, Landry, and Stewart).

According to these experts, the extent to which these PDO and ENSO warming cycles have affected depleted marine mammal stocks is unknown, but potentially significant. One expert concluded that it is unlikely that the ecological structure of the ETP has changed substantially in a way that could significantly impede or promote the population growth of depleted stocks. (Report of Andrew Read). Others, expressed a different view. In Landry's view, "such changes provide a credible explanation for at least part of the observed slow recovery of dolphin stocks * * *." In the view of Stewart,

"the argument is persuasive that the carrying capacity of the ETP, relative to the ecologies and life histories of northern offshore spotted dolphins and eastern spinner dolphins, is lower now (and the past several or more years), that [sic] it was prior to and during the early phase of the fishery." Moreover, Stewart concludes that depleted stocks had begun to recover after direct mortality declined below the replacement rate in the 1980s, but that this recovery may have been interrupted by warm water events in the 1990s. Barber notes that, "There are indications that the biological productivity of the ETP has changed in response to the low-frequency physical variability known as PDO. These indications, while speculative, require that we not rule out the possibility that the carrying capacity of the ETP for dolphins has declined and that this decline has affected recovery of the population. * * * We also cannot rule out the possibility that the ecological structure of the ETP has changed substantially in a way that could impede the recovery of the dolphin stocks."

Panel experts agree with NOAA's view that there is insufficient information to adequately assess the existence or magnitude of ecosystem changes, or the extent to which these changes have impacted depleted dolphins. As one expert noted, " * * * we do not have a sufficient understanding of the structure or function of the ETP ecosystem to answer this question. Our knowledge of the ecological interactions of dolphins and other ecosystem components, including yellowfin tuna, is so rudimentary that in most cases, we cannot predict whether a particular environmental change might promote or impede the population growth of dolphins. Furthermore, we do not have a sufficient time-scale of observations to allow tests of hypotheses regarding such ecological changes and their effects." (Report of Andrew Read).

Comments of the IATTC state that between 1986–1990 and 1998–2000, population surveys indicate that large numbers of non-depleted dolphins moved into the fishery off Central America. By competing for common food sources, this migration could have significantly affected the carrying capacity of depleted dolphins and hindered recovery. The MMC commented that available information is insufficient to support a conclusion that ecosystem changes have impacted dolphin recovery, but the MMC provided no additional information on this point.