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NOTES

MASS STRANDINGS OF JUVENILE SHORTBELLY ROCKFISH AND PACIFIC HAKE ALONG THE COAST OF NORTHERN CALIFORNIA

Carcasses of young-of-the-year (YOY) shortbelly rockfish, *Sebastes jordani*, and Pacific hake, *Merluccius productus*, littered shores of northern California during June 1988. These strandings caused much concern among observers, but there was little understanding of why they occurred (Klineman 1988). Here we discuss our observations on these and other occurrences during recent years, and draw some conclusions.

At the same time that carcasses littered the beaches, we observed large schools of YOY shortbellies, many in poor condition, during underwater surveys (scuba) near shore along the Sonoma and Mendocino coasts. These were unusual occurrences. Although YOY shortbellies have dominated samples taken offshore by midwater trawl (Peter Adams, National Marine Fisheries Service, Tiburon Laboratory, unpubl. data) we have seen them only occasionally during hundreds of hours of observations near shore over the past 10 years.

The YOY shortbelly schools were most dense right up against rocky shores, where many filled the water from surface to bottom. Virtually every member of these shortline schools was marked by lacerations and/or abrasions, and moribund individuals were common. There were many dead YOY shortbellies on the bottom beneath the schools, and among them lay numerous dead hake. The hake, too, were lacerated and abraded, and, while no living individuals were seen (we have never seen living hake in this habitat), it was clear they had been feeding on the YOY shortbellies. The abdomens of most were greatly distended, and stomachs gorged with YOY shortbellies protruded from the partially decomposed bodies of some (Figure 1).

Probably it is normal that hake prey heavily on YOY shortbellies at this time of year, as do salmon and other coastal predators (Merkel 1957, Lenarz 1980, Chess et al. 1988). We assume that these encounters usually occur offshore above the continental shelf and slope, since that is where hake ordinarily feed (Alverson and Larkins 1969, Gotshall 1969). In fact, hake and YOY shortbellies may be ill-suited to shoreline interactions as predator and prey. Certainly feeding-related behaviors that are adaptive in open water can be maladaptive in confined surroundings. In particular, the explosive, straightforward charge typical of open-water predators, as well as the radiating, evasive response to such attacks typical of schooling prey, are risky maneuvers among rocks or at the water's edge. It is known, for example, that when schools of small fish are driven against the shoreline by large, active predators, subsequent actions often carry both predator and prey onto the beach (Hobson 1968).

The difficulties of maneuvering in confined space would be especially great at night, when visibility is reduced, and we believe that this is when the shortbellies were attacked. Being nocturnal predators (Hart 1973), hake should

function well in dim light. However, their night-feeding normally occurs in obstruction-free surface waters offshore (Alton and Nelson 1970, Livingston 1983), where there is no danger of stranding or of colliding with abrasive surfaces. We suggest that it was the inability of YOY shortbellies and hake to accommodate their behaviors to these dangers in the obstruction-filled waters near shore that resulted in the recently observed mortalities.

FIGURE 1. Carcasses of hake and shortbelly rockfish on the seabed beneath a shoreline YOY shortbelly school on the Sonoma coast. Arrow points to stomach gorged with YOY shortbellies (readily identifiable through the distended stomach wall) protruding from the decomposed body of a hake.

The acute stress evident in the YOY shortbellies and hake was in sharp contrast with the healthy condition evident in nearby members of the nearshore community. The neighboring residents included YOY of several *Sebastes* species, most notably blue rockfish, *S. mystinus*, black rockfish, *S. melanops*, and yellowtail rockfish, *S. flavidus*. These YOY rockfishes were numerous over most of the nearshore habitat, but, unlike the YOY shortbellies, they were not concentrated at the shoreline. Furthermore, we saw none that appeared in poor condition, none among the carcasses on shore, and none in the stomachs of hake. In fact, we have no evidence they were in any way stressed, which supports our conclusion that the problems suffered by the YOY shortbellies and hake resulted from being maladapted to nearshore conditions, not from problems suffered by the nearshore environment.

While it may be that the hake entered the nearshore habitat to feed on the YOY shortbellies, this still leaves us to question why the YOY shortbellies were there. That the strandings occurred during June follows from this being a time

of year when YOY shortbellies are particularly abundant off northern California (unpublished data from midwater-trawl surveys, Peter Adams, Tiburon Laboratory). But since these fish usually are some distance offshore, why during early June of 1988 were so many close enough inshore to become stranded?

The answer may involve the wind. The strong northerlies that prevail in this region during spring and summer drive the coastal surface waters seaward (Ekman 1904, Bakun 1973), and this acts to keep the YOY shortbellies offshore. But during the month before the strandings short periods of weaker-than-usual northerlies alternated with short periods of southerlies. And on the days immediately before and during our first observations of YOY shortbellies near shore, the wind was from the south at up to 14 knots (Figure 2). Sea temperatures near shore increased sharply at this time, indicating that the surface flow had turned toward the coast (Hobson and Chess 1988), and we believe that this is what brought the YOY shortbellies to the shore.

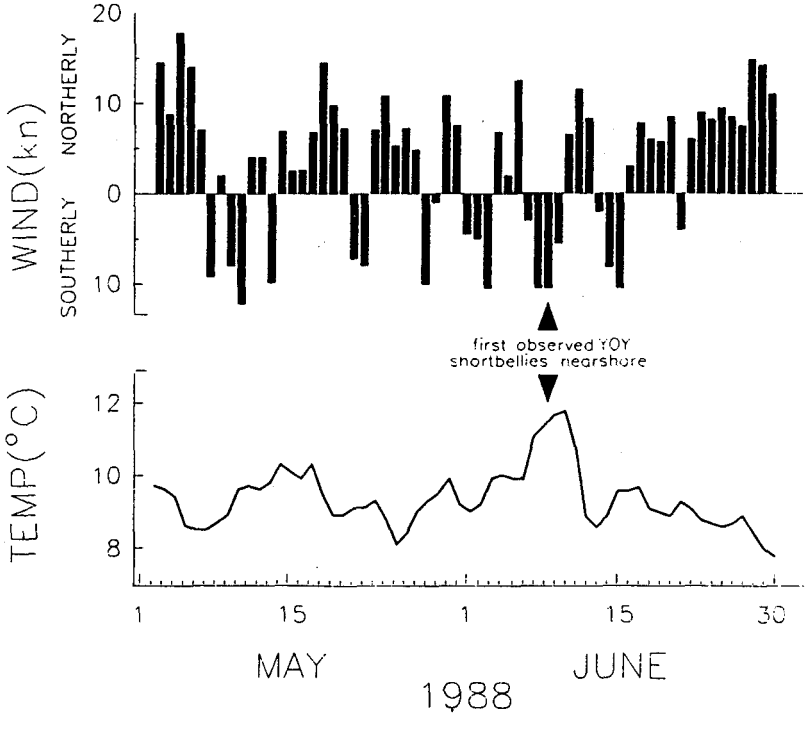

FIGURE 2. Relation between wind and sea temperatures nearshore off the Mendocino coast during May and June, 1988.

Plotted wind values are averages of 2–5 daily readings from the NOAA weather station at Mendocino. Southerly values represent winds from south of east-west axis, northerly values represent winds from north of this axis. *Plotted sea temperatures* are daily means of 72 readings of a digital recording thermometer placed at a depth of 10m in the nearshore habitat.

Previous nearshore occurrences of YOY shortbellies support this hypothesis. Only twice before during the past 10 yr of extensive work in these habitats have we seen large schools of YOY shortbellies close to shore, and both times (early

July 1982 and early June 1985) were similarly marked by southerly winds and abruptly elevated sea temperatures (E. Hobson, Tiburon Laboratory, unpubl. data). We are unaware of strandings during the 1982 episode, but in 1985 we saw YOY shortbellies stranded on the Marin coast, and received reports from fishermen of juvenile shortbellies and hake being stranded along the Mendocino coast. There also were widespread strandings of YOY shortbellies and hake along the Mendocino and Sonoma coasts during late June 1987 (Peter Kalvass, California Department of Fish and Game, pers. comm.), and while we lack wind data for that period (the weather station was closed that week), our thermograph record of sharply elevated sea temperatures indicates that these strandings occurred during an episode of shoreward surface transport. On the other hand, over this same 10-yr period there have been episodes of strong shoreward transport during June–July when no YOY shortbellies were seen near shore, so apparently there are other variables involved.

One of these other variables is likely to be the relative number of YOY shortbellies offshore, and this number differs greatly from year to year with the success of recruitment. Annual assessments of recruitment in this species, based on occurrences of YOY in the gut contents of king salmon, *Oncorhynchus tshawytscha*, have been made since 1980 by Peter Adams and Wayne Samiere, of the Tiburon Laboratory. Significantly, their unpublished results indicate strong recruitment during the four years that YOY shortbellies were noted by us or others to be unusually abundant near shore. Furthermore, their data indicate relatively weak recruitment during the other six years, which may explain why occasional periods of strong shoreward transport during June–July of those years did not, to our knowledge, bring YOY shortbellies near shore.

LITERATURE CITED

Alton, M. S. and M. O. Nelson. 1970. Food of the Pacific hake, *Merluccius productus*, in Washington and northern Oregon coastal waters. U. S. Fish Wildl., Circ. 332:35–42.

Alverson, D. L. and H. A. Larkins. 1969. Status of knowledge of the Pacific hake resource. CalCOFI Rept., 13:24–31.

Bakun, A. 1973. Coastal upwelling indices, west coast of North America, 1946–71. U.S. Dep. Commer., NOAA Tech. Rep. NMFS SSRF 671, 103p.

Chess, J. R., S. E. Smith, and P. F. Fischer. 1988. Trophic Relationships of the shortbelly rockfish, *Sebastes jordani*, off central California. CalCOFI Rept., 29:129–136.

Ekman, V. W. 1904. On the influence of the earth's rotation on ocean currents. Ark. Mat. Astron. Fys., 2, 11:1–52.

Gotshall, D. W. 1969. Stomach contents of Pacific hake and arrowtooth flounder from northern California. Calif. Fish and Game, 55:75–82.

Hart, J. L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada, Bull. 180, 740p.

Hobson, E. S. 1968. Predatory behavior in some shore fishes in the Gulf of California. Bur. Sport Fish Wildl. Res. Rpt. 98, 92p.

_____, and J. R. Chess. 1988. Trophic relations of the blue rockfish, *Sebastes mystinus*, in a coastal upwelling system off northern California. Fish. Bull., 86:715–743.

Klineman, E. 1988. Thousands of fish die mysteriously along coast. The Press Democrat, Santa Rosa, Calif. 18 June, p.1.

Lenarz, W. H. 1980. Shortbelly rockfish, *Sebastes jordani*: a large unfished resource in waters off California. Mar. Fish. Rev., 42:34–40.

Livingston, P. A. 1983. Food habits of Pacific whiting, *Merluccius productus*, off the west coast of North America, 1967 and 1980. Fish. Bull., 81:629–636.

Merkel, T. J. 1957. Food habits of the king salmon, *Onchorhynchus tshawytscha* (Walbaum), in the vicinity of San Francisco, California. Calif. Fish and Game, 43:249–270.

—Edmund S. Hobson and Daniel F. Howard, Southwest Fisheries Center, Tiburon Laboratory, 3150 Paradise Drive, Tiburon, CA 94940. *Accepted for publication January 1989.*

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