# NON-EXPLOITED FISH AND INVERTEBRATES

Non-exploited fish and invertebrates are those species which are not caught as commercial species and therefore recorded or assessed in "official" statistics. They include many species which are caught incidentally (non-target species) in fishing operations, and include species which are caught in "traditional" or artisanal fisheries. They include fish and invertebrates which live on the bottom (benthos), near the bottom (demersal), and/or up in the water column (pelagic). Benthic animals are important scavengers and decomposers of organic material that fall to the bottom, and are therefore important to the recycling of nutrients. They are also important prey items for fish which feed on our near the bottom (demersal fish). Many of these species are relatively small, and are called micronekton. They can also be very important links in the food webs from smaller zooplankton to large fish, seabirds, and mammals – such species area also often called "forage fish" because they are key prey items (forage) for larger fish. They are often difficult to capture in commercial fisheries, either because they are too dispersed or live in habitats which are too difficult to fish commercially. Along with phytoplankton and zooplankton, non-exploited fish and invertebrates include the largest number of un- or poorly-described and counted species in the North Pacific.

## YELLOW SEA / EAST CHINA SEA

In the northern Yellow Sea, the biomass of zoobenthos was higher than in the central and southern regions. The seasonal maximum of 49.68 g $m^{-2}$ occurred in the spring, and seasonal means were 39.14 g $m^{-2}$ in winter, 38.05 g $m^{-2}$ in autumn, and 37.85 g $m^{-2}$ in summer. In the central and southern Yellow Sea, the mean biomass was 19.71 g $m^{-2}$. Here, the maximum, 27.36 g $m^{-2}$, also occurred in the spring. In other seasons, mean biomass did not vary significantly, ranging from 17.29 g $m^{-2}$ in summer, 16.39 g $m^{-2}$ in autumn and 16.38 g $m^{-2}$ in winter.[1] Molluscs account for over 55% of the total biomass, the echinoderms, polychaetes and crustaceans, approximately 20%, 15% and 10% respectively, and the remaining species groups, about 5%.

Korean studies, however, showed somewhat different results. Along the Korean coastline, higher biomass has been reported, ranging from 79.44 - 171.6 g $m^{-2}$. Abundance ranged from 769 - 1,939 ind. $m^{-2}$. A total of about 500 species has been reported comprising 135 mollusks, 148 arthropods, 87 annelids, 24 echinoderms, 34 cnidarians, and 7 poriferan species.[2] Such differences are at least partly related to different sampling methods and strategies.

## SEA OF OKHOTSK

About 61 species of mesopelagic fish belonging to 53 genera and 33 families have been recorded in the Okhotsk Sea midwater layer.[3] According to data collected in trawl surveys between 1987-1991, the total mesopelagic fish biomass ranged from 19 to 30 million t.[4] Northern smoothtongue (*Leuroglossus schmidti*) predominated and contributed about half of this value: 42-66%. Another bathylagid fish, *Lipolagus ochotensis*, and several myctophids (*Stenobrachius nannochir*, *S. leucopsarus*, *Diaphus theta*) are also important members of mesopelagic fish community. Squid are also a very important item in the food web of the Okhotsk Sea ecosystem. Sixteen species of squid, belonging to nine genera and six families, are known there. The family *Gonatidae* contains ten species, two of which (*Berryteuthis magister* and *Gonatopsis borealis*) are the most abundant cephalopods.[5,6] Total squid biomass was estimated at 3.5–4 million t in the 1990s, and the annual consumption of squid is about 12 million t, a figure made possible by the highly productive characteristics of this group of animals.

## KUROSHIO - OYASHIO / WESTERN SUBARCTIC GYRE / GULF OF ALASKA / BERING SEA / CENTRAL NORTH PACIFIC TRANSITION ZONE

These regions are combined here as they include the deep oceanic areas of the North Pacific. Dominant non-exploited species groups here are mostly defined as “Micronekton” - a group of organisms mainly composed of large-sized euphausiids, shrimps, and small-sized fishes and squids. It also includes the ”micronektonic early life stages” of all larger fishes and squids such as anchovy, sardine, mackerel, albacore tuna, skipjack tuna, Japanese common squid, and neon flying squid.

The most important mesopelagic fishes in these regions are the families Myctophidae and Bathylagidae, which are the most abundant by numbers and biomass (making up 80 to > 90 % of total microneckton fish catch). The principal species are:

- Myctophidae – Lanternfishes - 15 000 000 tonnes
  - Northern lampfish (*Stenobrachius leucopsarus)* 42-86% of total
  - Bigeye lanternfish (*Protomyctophum thompsoni*)
  - California headlightfish (*Diaphus theta*)
  - Garnet lanternfish (*S. nannochir*)
  - Bigfin lanternfish (*Symbolophorus californiese*)
  - Pinpoint lampfish (*Lampanyctus regalis*)
  - Broadfin lampfish (*L. ritteri*)
  - Blue lanternfish (*Tarletonbeania crenularis*)
  - Dogtooth lampfish (*Ceratoscopelus townsendi*)
- Bathylagidae – Deepsea smelts
  - Northern smoothtongue (*Leuroglossus schmidti)*
  - Eared blacksmelt (*Bathylagus ochotensis*)
  - Slender blacksmelt *(B. pacificus)*
- Stomiidae – Barbeled dragonfishes
  - Pacific viperfish (*Chauliodus macouni*)
- Melamphaeidae – Melamphids (Bigscales)
  - Highsnout melamphid (*Melamphaes lugubris)*
  - Crested melamphid (*Promitra crassiceps*)
- Scopelarchidae – Pearleyes
  - Northern pearleye (*Benthalbella dentata*)
- Gonostomatidae – Bristlemouths
  - Slender fangjaw (*Gonostoma gracile)*
  - Black bristlemouth (*Cyclothone atravia*)
  - Tan bristlemouth (*C. pallida*)
  - Phantom bristlemouth (*C. pseudopallida*)

Mesopelagic cephalopods are also important components of the micronekton of the subarctic and transitional North Pacific Ocean. “Micronektonic” cephalopods are those species that are <60 mm length; this includes some adults, but mostly the larval and juvenile stages of larger oceanic cephalopod species:

- Families
  - Enoploteuthidae (17 species in 4 genera)
    - Key species are in their respective ecosystems are *Abraliopsis feltis; Watasenia scintillans*
  - Gonatidae (17 species in North Pacific)
    - Account for majority of N. Pac. cephalopods
  - Onychoteuthidae (5 species in N. Pacific)

- Pyroteuthidae (4 species from 2 genera)

- Other Families
  - Ommastrephidae (most commercially important)
  - Chiroteuthidae; Mastigoteuthidae; Cranchiidae

Regional descriptions of families/species of micronektonic fish and invertebrates and their relative abundances are indicated in Table 1.

Table 1.

Table 1 Occurrence of adults and larvae of the subarctic and transitional water fishes belonging to Myctophidae and Bathylagidae in the northern North Pacific . The species are grouped according to their adult distributions hitherto reported. A and (A) indicate common and rare occurrence of adult, respecitvily. L indicates common larval occurrence and (L) denotes larval occurrence in the marginal waters adjacent to the main spawning water mass defined by the larval occurrence. No previous record is indicated by dash. TrD, Transitional Domain; TrZ, Transitional Zone; SAC, Subarctic Current; RD, Ridge Domain (see text for the definition of water masses)

| | Western Transition waters | | | | Western Subarctic waters (SAW) | | | | Calif. Current & eastern Transition Domain waters | | | | | | eastern SAW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | TrZ waters | | TrD waters | | Oyashio waters | | western SAW | | Calif. Current water | | off Oregon | | Alaska Current & St | | RD & SAC | |
| | Adult | Larvae | Adult | Larvae | Adult | Larvae | Adult | Larvae | Adult | Larvae | Adult | Larvae | Adult | Larvae | Adult | Larvae |
| Transpacific SAW-TrW species | | | | | | | | | | | | | | | | |
| Myctophidae | | | | | | | | | | | | | | | | |
| *Stenobrachius leucopsarus* | A | L | A | - | A | - | A | - | A | L | A | L | A | L | A | (L) |
| *S. nannochir* | A | (L) | A | L | A | - | A | - | (A) | - | A | - | A | - | A | - |
| *Diaphus theta* | A | L | A | (L) | A | (L) | A | - | A | L | A | - | A | - | A | - |
| *Protomyct. thompsoni* | A | L | A | L | A | (L) | A | - | A | L | A | L | A | L | A | (L) |
| *Nannobrachium regale* | A | (L)* | A | - | A | - | A | - | A | L | A | L | A | (L) | A | (L) |
| Bathylagidae | | | | | | | | | | | | | | | | |
| *Bathylagus ochotensis* | A | - | A | - | A | - | A | - | A | L | A | L | A | (L) | A | - |
| *B. milleri* | A | L | A | L | A | (L) | A | - | A | L | A | L | A | - | A | - |
| *B. pacificus* | A | L | A | L | A | L | A | - | A | L | A | L | A | (L) | A | - |
| *Leuroglossus schmidti* | A | L | A | L | A | L | A | L | A | L | A | L | A | L | A | L |
| | | | | | | | | | | | | | | | | |
| Transpacific TrW species | | | | | | | | | | | | | | | | |
| Myctophidae | | | | | | | | | | | | | | | | |
| *Protomyct. crockeri* | A | - | - | - | - | - | - | - | A | L | A | L | - | - | - | - |
| *Symb. californiensis* | A | L | A | - | (A) | - | (A) | - | A | L | A | - | - | - | (A) | - |
| | | | | | | | | | | | | | | | | |
| Westen SAW & TrW species | | | | | | | | | | | | | | | | |
| Myctophidae | | | | | | | | | | | | | | | | |
| *Tarletonbeania taylori* | A | (L) | A | L | A | - | A | - | - | - | - | - | - | - | - | - |
| *Lampanyctus jordani* | A | (L) | A | L | A | - | A | - | (A) | - | - | - | - | - | A | - |
| *Notoscopelus japonicus* | A | - | A | - | A | - | (A) | - | - | - | - | - | - | - | (A) | - |
| *Diaphus gigas* | A | - | A | - | (A) | - | (A) | - | - | - | - | - | - | - | - | - |
| | | | | | | | | | | | | | | | | |
| Bathylagidae | | | | | | | | | | | | | | | | |
| *Melanolagus bericoides* | - | - | - | - | A | - | A | - | - | - | - | - | - | - | - | - |
| | | | | | | | | | | | | | | | | |
| Eastern SAW or TrW species | | | | | | | | | | | | | | | | |
| Myctophidae | | | | | | | | | | | | | | | | |
| *Tarletobeania crenularis* | - | - | - | - | - | - | | - | A | L | A | L | A | L | A | (L) |
| *Nannobrachium ritteri* | - | - | - | - | - | - | - | - | A | L | A | (L) | A | (L) | (A) | - |
| | | | | | | | | | | | | | | | | |
| Bathylagidae | | | | | | | | | | | | | | | | |
| *Bathylagus berycoides* | - | - | - | - | - | - | - | - | A | - | A | - | - | - | - | - |
| *B. wesethi* | - | - | - | - | - | - | - | - | A | L | A | - | A | - | A | - |
| *Leuroglossus stilbius* | - | - | - | - | - | - | - | - | A | L | A | - | A | - | A | - |

In the **Kuroshio** region, decadal changes in abundance of surface migratory myctophid fishes was examined for a period of 35 years from 1957 to 1994.[7] The abundance of juvenile *Symbolophorus evermanni*, *Centrobranchus brevirostris*, and *Myctophum nitidulum* showed prominent peaks in 1971 (Figure 1), as did adult *M. nitidulum*. These peaks corresponded to an extraordinarily high abundance of zooplankton in the Kuroshio region in 1971, suggesting that good recruitment and low adult mortality had occurred in these surface migratory myctophids.

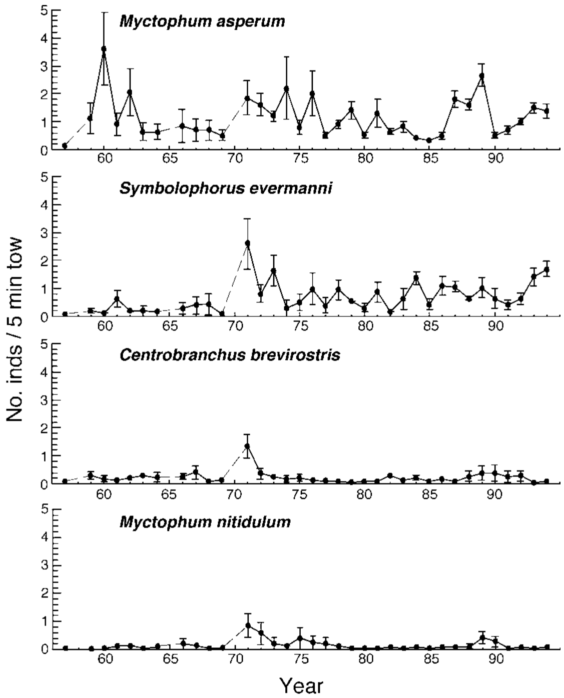


**FIGURE 1 ANNUAL FLUCTUATION IN THE AVERAGE CATCHES OF JUVENILES (STANDARD LENGTH ≤ 40 MM) OF THE SURFACE MIGRATORY MYCTOPHID SPECIES OVER 35 YEARS, FROM 1957 TO 1994. THE BARS INDICATE THE STANDARD ERROR.**

In the coastal and continental shelf areas of the **Gulf of Alaska**, common forage fish species include Pacific sandfish (*Trichodon trichodon*), Pacific sandlance (*Ammodytes hexapterus*), capelin (*Mallotus villosus*), eulachon (*Thaleichtys pacificus*), gunnels (family Pholidae) and pricklebacks (family Stichaeidae). Abundances of these species are difficult to assess as they are not retained will by the trawl nets typically used in these areas to sample fish. Instead, the frequency of occurrence of these species in trawl catches has been used as a relative index of changes in abundance (Figure 2). The average annual biomass (1984-2003) of key forage fish species in the Gulf of Alaska have been estimated from trawl surveys to be (Nelson, M. 2003. Forage fish species in the Gulf of Alaska. NPFMC Gulf of Alaska SAFE, pages 757-770):

Table 2.

| | Gulf of Alaska average annual biomass 1984 - 2003 (mt) |
|---|---|
| Pacific sand lance | 16 |
| Capelin | 5,329 |
| Pacific sandfish | 1,168 |
| eulachon | 37,348 |
| pricklebacks | 398 |

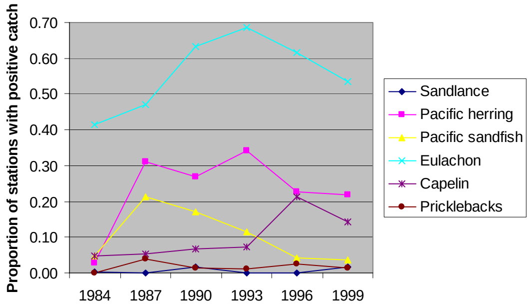


**FIGURE 2 TRENDS IN FREQUENCY OF OCCURRENCE OF 6 GROUPS OF FORAGE FISHES IN THE EASTERN GULF OF ALASKA BOTTOM TRAWL SURVEYS (EAST OF 147°W) FROM 1984-1999. ONLY THE INCREASE IN CAPELIN WAS STATISTICALLY SIGNIFICANT AT A 95% CONFIDENCE LEVEL. ESTIMATES PRIOR TO 1990 SHOULD BE VIEWED WITH CAUTION DUE TO DIFFERENCES IN GEAR.**

Abundances, and their changes, of other non-exploited species in the **Gulf of Alaska** can also be determined from bottom trawl surveys. Abundance trends for several groups are summarized in Figure 3 and suggest significant increases in sharks (spiny dogfish, *Squalus acanthias*, and Pacific sleeper shark, *Somniosus pacificus*), skates (Rajidae), grenadiers (primarily *Albatrossia pectoralis*), and yellow Irish lord (*Hemilepidotus jordani*), whereas other sculpins (primarily *Myoxocephalus* sp. and *Hemitripterus bolini*) decreased significantly. Trends in several non-commerical invertebrate groups suggest large increases over time in the frequency of occurrence of starfishes, sea urchins, snails, sponges, bryozoans, and other invertebrate groups.

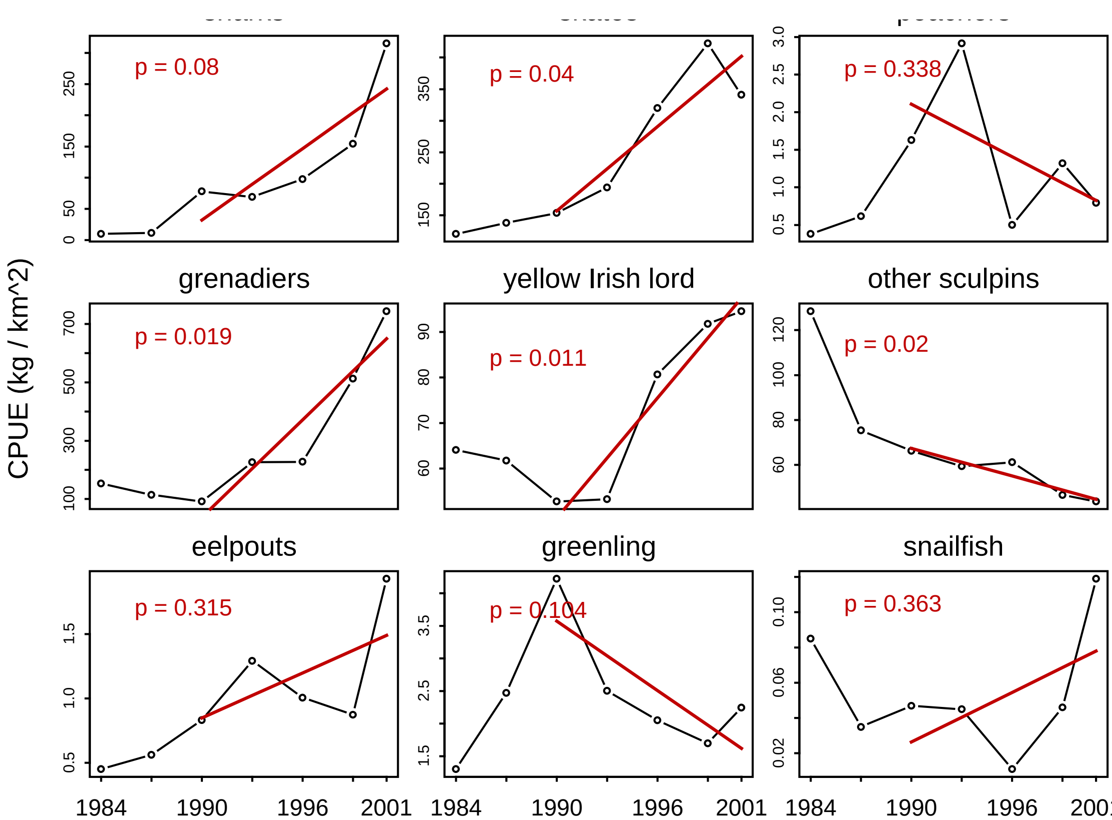


**FIGURE 3 TRENDS IN CATCH-PER-UNIT-EFFORT FOR NINE NON-COMMERCIAL FISH GROUPS IN THE WESTERN GULF OF ALASKA (WEST OF 147°W) FROM 1984-2001. ESTIMATES PRIOR TO 1990 SHOULD BE VIEWED WITH CAUTION DUE TO DIFFERENCES IN GEAR. TREND LINES AND P-VALUES ARE BASED ON SIMPLE LINEAR REGRESSIONS OF CPUE ON YEAR FROM 1990-2001**

## California Current

Annual surveys conducted in the vicinity of the Columbia River since 1999 indicate that forage fish (whitebait smelt (*Allosmerus elongatus*), Pacific herring *Clupea harengus pallasi*, and northern anchovy) abundance has increased from very low levels in 1999 (
Figure 4).

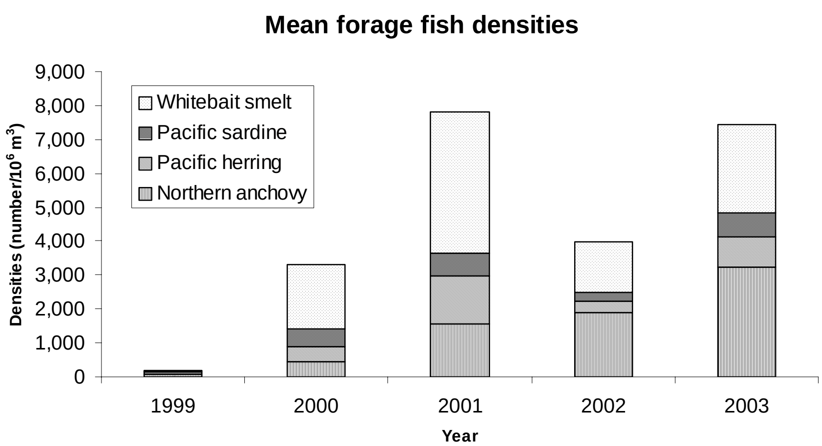


**FIGURE 4 THE MEAN DENSITY OF FORAGE FISHES (WHITEBAIT SMELT, PACIFIC HERRING, NORTHERN ANCHOVY, AND PACIFIC SARDINE) OFF N OREGON/S WASHINGTON FROM APRIL TO JULY.[8]**

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[6] Lapko, V.V. 1995. Role of squids in communities of Okhotsk Sea. *Oceanology* 35(5): 737-742 (In Russian).
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