# A nearsurface, daytime occurrence of two mesopelagic fish species (*Stenobrachius leucopsarus* and *Leuroglossus schmidti*) in a glacial fjord

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The northern lampfish (*Stenobrachius leucopsarus*, family Myctophidae) and northern smoothtongue (*Leuroglossus schmidti*, family Bathylagidae) are mesopelagic fishes, defined by their vertical distribution in the mesopelagic zone (200–1000 m) during daylight hours. Northern lampfish range from the Bering Sea to southern California (Shimada, 1948), where their abundance is highest along the continental slope and decreases over the continental shelf. They are the most abundant species in the mesopelagic zone of the Bering Sea (Pearcy et al., 1977; Sobolevsky et al., 1996), the Gulf of Alaska (Purcell, 1996), and the eastern North Pacific Ocean off Oregon (Pearcy, 1964; Pearcy et al., 1977). Northern smoothtongue also concentrate in areas bordering the continental slope and are widely distributed from southern British Columbia to the Bering Sea (Peden, 1981) and are very abundant in the Okhotsk Sea (Sobolevsky et al., 1996).

Although larval myctophids spend day and night in nearsurface waters (Frost and McCrone, 1979), juvenile and adult northern lampfish typically inhabit depths of 300–600 m during the day (Paxton, 1967; Pearcy et al., 1977; Frost and McCrone, 1979; Sobolevsky et al., 1996; Watanabe et al., 1999). Off the Oregon coast northern lampfish exhibit semimigrant behavior: a large portion of the population migrates from a daytime depth of 300–600 m to about 50 m at night, and a nonmigratory portion of the population has both a day- and night-time vertical distribution at about 500 m depth (Pearcy et al., 1977). This semimigrant behavior also occurs in the Gulf of Alaska (Frost and McCrone, 1979), in the western North Pacific off Japan (Watanabe et al., 1999), and off California in both the San Pedro Basin (Paxton, 1967) and Santa Barbara Basin (Cailliet and Ebeling, 1990). After sunset, migratory northern lampfish have been collected at depths as shallow as 20 m in the Bering Sea (Nagasawa et al., 1997). We are unaware of any studies in which adult northern lampfish were collected at depths of less than 100 m prior to sunset.

Northern smoothtongue migrate from the mesopelagic zone (200–1000 m) in the day to the epipelagic zone (0–200 m) after sunset (Sobolevsky et al., 1996). Larval northern smoothtongue are abundant in the upper 50 m of Alaskan coastal waters during daylight (Haldorson et al., 1993; Norcross and Frandsen, 1996), but after the postlarval and early juvenile stages they are typically found at depths greater than 150 m (Taylor, 1968; Mason and Phillips, 1985). Previous accounts of adult northern smoothtongue at shallow depths were those of collections made after sunset (Barraclough, 1967; references in Hart, 1973), and in some areas adults do not exhibit diel vertical migration but remain at depths below 240 m (Mason and Phillips, 1985). There has previously been no documentation of either juvenile or adult northern smoothtongue in the upper 50 m of the water-column prior to sunset. The purpose of our study was to document the nearsurface (<15 m), daytime occurrence of both juvenile and adult northern lampfish and northern smoothtongue in Glacier Bay, Alaska.

## Materials and methods

Glacier Bay is a fjord in Southeast Alaska that extends northward and bifurcates into a west arm and Muir Inlet (Fig. 1). We conducted 48 midwater trawl tows at 34 stations from 10 to 23 June 1999. Fishes were located with a Biosonics DT4000 digital 120-kHz echo sounder, and significant targets were fished with a modified herring mid-water trawl with a mouth opening of 50 $m^2$. Mesh sizes diminished stepwise from 5 cm in the wings to 1 cm at the codend, which was lined with 3-mm mesh. A plastic collecting bucket with 1-mm mesh was attached to the end of the codend, and was detached and rinsed after each tow. A Furuno net-sounding system monitored the depth of the headrope during fishing operations. A temperature depth recorder (TDR, Wildlife computers model MK7) was mounted on the headrope to determine the exact depth of the net during fishing oper-

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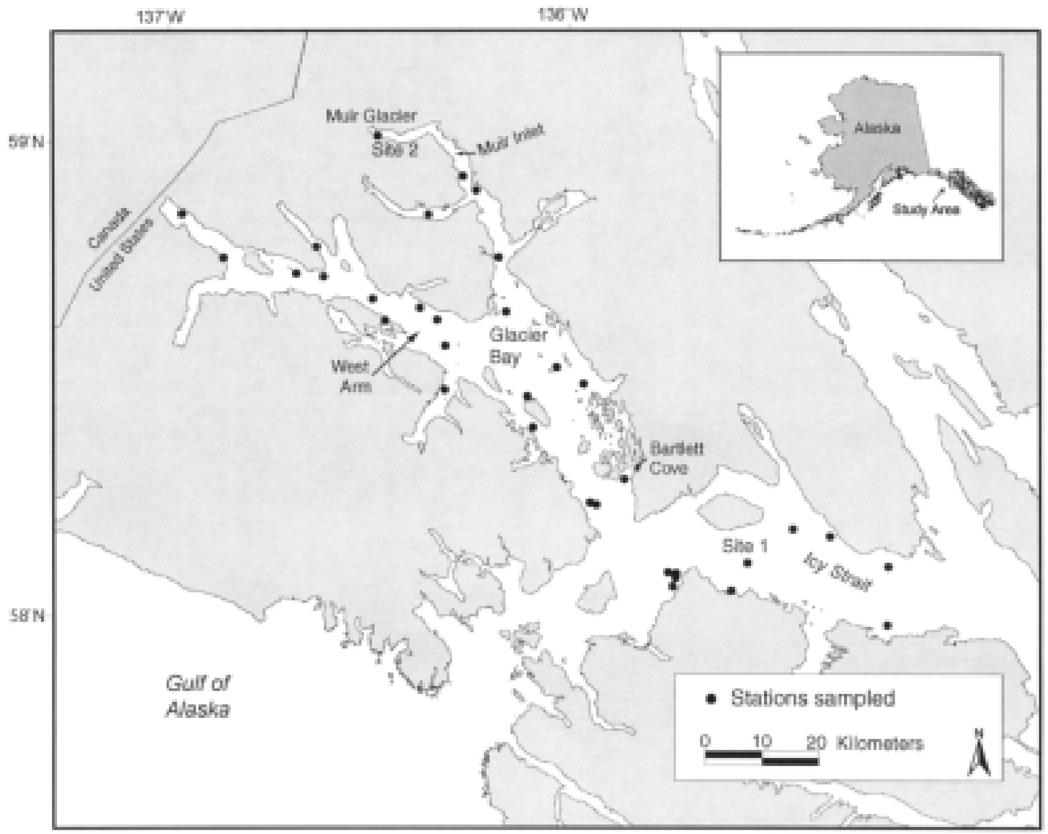


**Figure 1**

Stations (•) sampled by midwater trawl in Icy Strait and Glacier Bay, Alaska, during June 1999.

ations. Mid-water trawls were considered failures if the trawl doors crossed, the net mesh tore, or if the net-sounding system failed to detect the headrope of the trawl. These tows were omitted from data analysis.

We fished from a 22-m stern trawler, the RV *Pandalus*. The towing speed was about 2.5 kn, and the average tow duration was 20 minutes. There was one deep tow at site 1. At site 2 there were four tows, beginning with three shallow tows and ending with one deep tow to 100 m (Table 1). All fishing was done prior to sunset between 0839 and 1933 h ADT (Alaska daylight time). After fishing at a station, we deployed a CTD (Seabird Electronics Inc, SBE-19 SEACAT profiler) to measure water temperature (°C), salinity (ppt), density (kg/m$^3$), turbidity (FTU, formazine turbidity units), and chlorophyll concentration (µg/L). CTD measurements were taken every second and we present average values ($n$=3) of data collected in each 1-m depth interval. If multiple fishing tows were made at a station, only one CTD cast was made.

All fishes were identified in the field to the lowest possible taxon, counted, and fork length (FL) was measured to the nearest millimeter. Length-frequency histograms were plotted for northern lampfish and northern smoothtongue, and fish lengths were grouped in increments of 2 mm. Ages were estimated from length-frequency histograms based on previous studies of length-at-age and length-at-maturity for northern lampfish (Smoker and Pearcy, 1970; Nagasawa et al., 1997) and northern smoothtongue (Mason and Phillips, 1985; Sobolevsky and Sokolovskaya, 1996).

## Results

Both mesopelagic species were captured infrequently; northern lampfish were present at only two of the 34 stations ($n$=60) and northern smoothtongue at only one station ($n$=133, Table 1). Northern lampfish and northern smoothtongue accounted for only 4% of the 5011 fish captured at all 34 stations; capelin (51%, *Mallotus villosus*) and walleye pollock (36%, *Theragra chalcogramma*) were the most abundant species. Northern lampfish mature at 4 years of age, and of the 60 individuals captured, about 86 % were juveniles (31–59 mm FL) and 14% were adults (65–83 mm FL). Northern smoothtongue mature at 2 years of age, and of the 133 individuals captured, about 64% were juveniles (35–53 mm FL) and 36% were adults (54–85 mm FL, Fig. 2).

At site 1, two individual northern lampfish (sizes 31 and 37 mm) were captured at 90 m depth during daylight (Fig. 1, Table 1). At site 2, next to Muir Glacier, we fished during daylight hours from 1730 to 1930 h. In the first tow (4.5 hours prior to sunset), we fished at 10–15 m depth and 12% of the northern lampfish were adults

**Table 1**

Station information from the two sites where northern lampfish (*Stenobrachius leucopsarus*) and northern smoothtongue (*Leuroglossus schmidti*) were present. The number of each species captured is given. Listed values of water temperature (°C), salinity (ppt), density (kg/m$^3$), turbidity (FTU), and chlorophyll concentration (µg/L) are those which correspond to the fishing depth.

| | | Site 2 | | | |
|---|---|---|---|---|---|
| | Site 1 | Tow 1 | Tow 2 | Tow 3 | Tow 4 |
| Northern lampfish (no.) | 2 | 57 | 0 | 0 | 1 |
| Northern smoothtongue (no.) | 0 | 81 | 0 | 0 | 52 |
| Region | Icy Strait | Muir Inlet | Muir Inlet | Muir Inlet | Muir Inlet |
| Date | 6/12/99 | 6/15/99 | 6/15/99 | 6/15/99 | 6/15/99 |
| Time of day | 1540 | 1730 | 1830 | 1850 | 1930 |
| Time prior to sunset (hour: min) | 6:23 | 4:36 | 3:36 | 3:16 | 2:36 |
| Latitude (North) | 58° 16.28′ | 59° 04.27′ | 59° 04.13′ | 59° 03.95′ | 59° 04.44′ |
| Longitude (West) | 135° 37.38′ | 136° 19.93′ | 136° 19.07′ | 136° 19.07′ | 136° 19.59′ |
| Bottom depth (m) | 124 | 187 | 187 | 187 | 187 |
| Fishing depth (m) | 90 | 10-15 | 10 | 20 | 100 |
| Temperature (°C) | 5.77 | 5.18 | 5.69 | 4.83 | 4.28 |
| Salinity (ppt) | 32.07 | 30.37 | 29.70 | 30.73 | 31.15 |
| Density, sigma-theta (kg/m3) | 25.29 | 23.99 | 23.40 | 24.31 | 24.69 |
| Turbidity (FTU) | 8.09 | 14.97 | 15.14 | 14.67 | 11.69 |
| Chlorophyll concentration (µg/L) | 1.61 | 1.38 | 2.15 | 1.30 | 0.86 |

and 88% were juveniles. At 100 m (tow 4) only one northern lampfish (44 mm FL) was captured. Northern smoothtongue were also captured at depths of both 10–15 m (tow 1) and 100 m (tow 4), and both catches consisted of 39% adults and 61% juveniles.

Among all stations, oceanic parameters measured at the depth of fishing had the following ranges: temperature (4.3–8.2°C), salinity (26.3–32.1 ppt), density (20.7–25.3 kg/m$^3$), turbidity (7.3–15.1 FTU), and chlorophyll concentration (0.9 – 25.4 µg/L). Vertical profiles of water temperature (°C), salinity (ppt), and density (kg/m$^3$) at sites 1 and 2 indicated that the thermocline, halocline, and pycnocline occurred at depths <10 m. The upper 10 m of the water column at site 2 had the lowest average surface salinity (26.3 ppt) and the highest turbidity of any of the 34 stations sampled in our study. Turbidity values at site 2 were >15 FTU from 3 to 16 m and >10 FTU to depths of 41 m; turbidity at site 1 was low and ranged from 7.8 to 8.7 FTU (Fig. 3). At site 2 the maximum chlorophyll concentration (16.1 µg/L) occurred at 5 m; whereas at site 1 the chlorophyll concentration peaked (24.7 µg/L) at 12 m and remained high (>10 µg/L) to 28 m.

## Discussion

Prior to sunset, juvenile and adult mesopelagic fishes were found at depths of 10 to 15 m near Muir Glacier in Glacier Bay, Alaska. Diel migrations of northern lampfish may be a response to light intensity (Paxton, 1967; Pearcy et al., 1977) or be stimulated by hunger (Pearcy et al., 1977; Cailliet and Ebeling, 1990). In the spring–summer period, when daylight hours increase in the Bering Sea, vertical migrations of northern lampfish and northern smoothtongue had smaller amplitudes and were not as distinct (Sobolevsky et al., 1996). Phytoplankton blooms and fog banks can reduce the depth to which light can penetrate, also causing northern lampfish to migrate higher in the water column (Barham, 1957).

Turbidity in the upper water layer next to Muir Glacier was higher than anywhere else in this study (15 FTU), and this high turbidity corresponded with the shallowest occurrence of mesopelagic fishes. In contrast, in Icy Strait at site 1, where the turbidity was lower, northern lampfish were captured at 90 m depth during daylight hours (Table 1, Fig. 3). High turbidity from glacial silt at Muir Glacier may significantly reduce light penetration and account for the presence of northern lampfish and northern smoothtongue at 10–15 m depth prior to actual sunset.

Although these mesopelagic fishes are more commonly distributed along the continental slope, both northern lampfish (Shimada, 1948; Taylor, 1968) and northern smoothtongue (Mason and Phillips, 1985) also occur in deep, nearshore waters from the eastern Gulf of Alaska to Puget Sound, Washington. Northern lampfish were observed in Icy Strait and Lower Glacier Bay, Alaska, previously,[1] but not as far inland as Muir Glacier. Northern smoothtongue have not been observed previously in the same area. Their occurrence along the inside waters and fjords of Southeast Alaska makes them available to a suite of predators that otherwise might feed upon them only offshore.

[1] Wing, B. 2000. Personal commun. National Marine Fisheries Service, Auke Bay Laboratory, 11305 Glacier Highway, Juneau, Alaska, 99801.

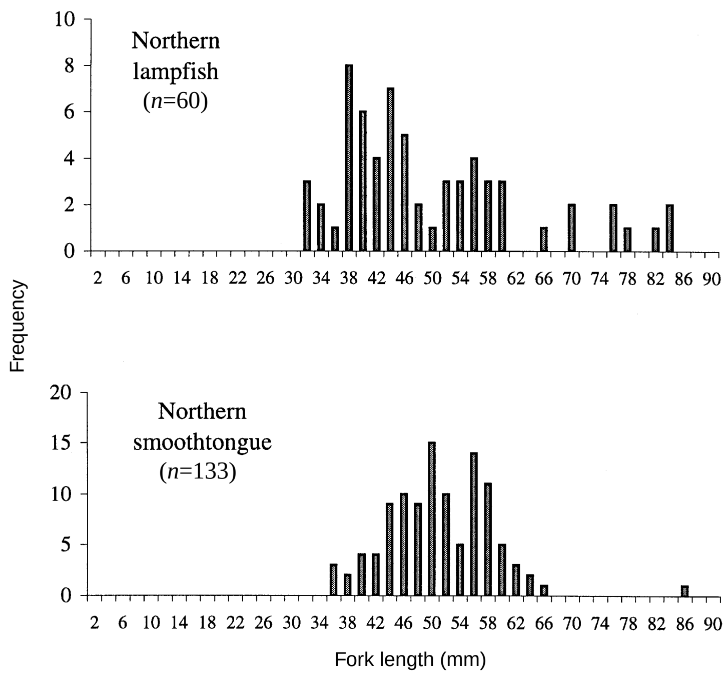


**Figure 2**

Length-frequency histograms for northern lampfish (*Stenobrachius leucopsarus*) and northern smoothtongue (*Leuroglossus schmidti*). Lengths were grouped in 2-mm intervals. The total number of fish that were measured is given in parentheses.

Northern lampfish and northern smoothtongue serve as important links in oceanic food webs (Cailliet and Ebeling, 1990). Myctophids provide a high-lipid energy source for a variety of predators (Van Pelt et al., 1997; Springer et al., 1999). For example, stomachs of marbled murrelets (*Brachyramphus marmoratus*) collected at the entrance to Glacier Bay contained northern lampfish almost exclusively.[2] Black-legged kittiwakes (*Rissa tridactyla*), which are restricted to foraging on fish at the surface, must feed nocturnally to obtain northern lampfish at oceanic islands in the Aleutians (Springer et al., 1996). However, near Muir Glacier and other tide-water glaciers in Glacier Bay, kittiwakes may be able to regularly forage on myctophids during daylight hours. Further investigations of fish distributions and predator diets are necessary to understand trophic interactions in Alaska's glacial fjords such as Glacier Bay.

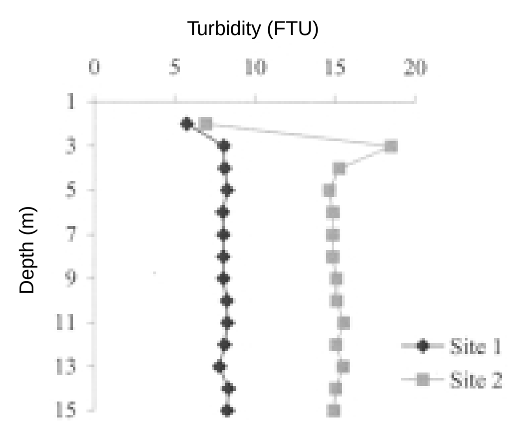


**Figure 3.**

Vertical profiles of turbidity (FTU, formazine turbidity units) at site 1 and site 2 from the surface to 15 m depth. Black diamonds symbolize data from site 1 and gray squares symbolize data from site 2.

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[2] Piatt, J. F. 1991. Unpubl. data. U.S. Geological Survey, 1011 E. Tudor Road, Anchorage, Alaska, 99503.

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