

*Charlton*  
*Am*

COMMERCIAL FISHERIES RESEARCH AND DEVELOPMENT ACT  
PROGRESS REPORT

Study on the Vertical Distribution and Movement of Pink Shrimp, Pandalus  
jordani, in the Pacific Ocean off Oregon

July 1, 1967 - June 30, 1968

Prepared by: Gary Milburn and Jack G. Robinson, Aquatic Biologists  
Fish Commission of Oregon

July 1968

U.S. Department of Interior  
Fish and Wildlife Service  
Bureau of Commercial Fisheries  
Sub-project No. 1-3-R-3  
Contract No. 14-17-0007-830

## ABSTRACT

Research cruises were made between August 28, 1967, and June 19, 1968, to study the vertical distribution and movements of pink shrimp, Pandalus jordani, off Tillamook Head in 68-80 fathoms. Shrimp traps suspended from surface to bottom, midwater trawl, and bottom shrimp trawl nets were used. Results are discussed in general terms and problems encountered are described. Shrimp were found to migrate off bottom rapidly at night. No apparent correlation between moon phase and migration was indicated. Data on moon phase-migration pattern are limited, however, due to weather and/or cloudy conditions. Seasonal differences in vertical migration in the study area (sex composition and height of migration) were indicated, probably due to (1) sex segregation and (2) presence or absence of thermocline. Few shrimp were caught in pots during May and June 1968, possibly due to a change in feeding habits. Differences in sex composition of catches in pots and midwater trawl indicate the pots are probably biased toward catching females. These data await detailed analysis. Results will appear in a final report on this study next year.

## PROGRESS

During the year, 6 cruises totaling 19 separate trips to sea were made. We did all field work on the chartered trawl vessel Sunrise.

An area off Tillamook Head in 68-80 fathoms was chosen as the site for all pot fishing as well as bottom and midwater trawling. This is the closest area to Astoria which annually produces commercial quantities of pink shrimp. A student trainee was hired for the month of August 1967 to help assemble the gear. An Aquatic Biologist joined the staff in September 1967.

We anticipated starting the study using shrimp traps (pots) and midwater trawl in July or August, 1967. However, the net and trap materials were not received until late September. Prior to the arrival of the supplies cruises were made in May-June 1967 (Cruise Report 67-4) and August 1967 (Cruise Report 67-8), to compare day and night catch rates for shrimp on the ocean floor.

We used a 41-foot Gulf semi-balloon trawl for these tests. Day tows produced much higher catch rates (in the order of 10-1) than night tows over the same area. These tests were repeated in June 1968 (Cruise Report 68-5) with similar results. Incidence of males in catches were higher in day tows, indicating a possible greater night migration off bottom of males than the older females. Results are shown in Table 1.

Table 1. Bottom trawl day and night catch rates and sex composition of shrimp by cruise.

| Cruise | Period    | Catch/tow (lbs) |       | % males in catch (n) |       |
|--------|-----------|-----------------|-------|----------------------|-------|
|        |           | Day             | Night | Day                  | Night |
| 67-4   | 5/31-6/13 | 589.1           | 62.2  | 60.1                 | 45.6  |
| 67-8   | 8/28-8/30 | 148.3           | 15.3  | 59.6                 | 46.9  |
| 68-5   | 5/18-5/20 | 241.7           | 22.5  | 32.3                 | 26.4  |

We began constructing the traps and rigging the midwater trawl upon the arrival of supplies. We made a 3 day cruise immediately after receiving the midwater trawl to test gear handling techniques and net configuration (cruise report 67-10). We experienced no difficulties in handling the gear.

Storms through most of October prevented us from getting to sea. We constructed 50 pots during this period. We chose chopped fish for bait. This was available commercially in 50-pound sacks of frozen mink feed. It was composed of from 70-100% arrowtooth flounder (Atheresthes stomias).

Three cruises (16 separate trips) were made from late October 1967 to mid-June 1968 to fish pots, midwater trawl, and bottom trawl. Usually

17 pots were attached at 4- to 5-fathom intervals to a main line. Two or three main lines (strings) were fished from surface to bottom on each trip. Pots were usually pulled and checked at 3- to 4- hour intervals during the night. The construction, rigging, and method of fishing these pots have been summarized in several cruise reports. The pots caught shrimp at night in abundance during cruises 67-11 and 68-1. Shrimp ceased entering pots during cruise 68-5. During cruise 67-11 from October 26-November 18, 1967, we made 4 trips to sea. Shrimp were caught during all night sets of the pots. No shrimp were caught during the day. Males were predominant in the catches of trips 2 and 3 and completely dominated the catch of trip 4 (Figure 1). Very few shrimp were caught in the uppermost pots of each string. This lack of shrimp was probably due to the presence of a very strong thermocline during this period. Weather prevented us from fishing with the bottom trawl and only 2 tows were made with the 30-foot square midwater trawl. Males were predominant in these catches, amounting to 81% and 100% of the catch on trips 3 and 4 respectively (Figure 2). We have appreciable agreement in catch composition between pot and midwater trawl catches, predominately male. A commercial market sample, drawn in mid-September 1967, is the only data we have of sex and age composition for bottom catches. It was composed of 40% males (Figure 3).

During cruise 68-1 from January 23 to March 21, 1968, we made 5 trips to sea. Again, all night sets of the pots caught large numbers of shrimp. No shrimp were caught during the day. Females predominated in pot catches during this period; (Figure 1) the

reverse of results gained in cruise 67-11. Bottom tows also resulted in catches composed largely of females (Figure 3). Mid-water trawl catches, however, were composed of appreciably more males than in catches by the other gear, although less males occurred in midwater trawl catches during this cruise than in any others (Figure 2). Water temperatures were homogeneous (cruise report 68-1, Figure 1) and as many as 300 to 600 shrimp were caught in near surface pots as well as throughout the water column. One tow, made during cruise 68-2, caught shrimp composed largely of males during the same period (February 15) but slightly north and west of where we fished pots. The predominance of males in this tow (Figure 3) leads us to believe the reason for the difference in sex composition between cruises 67-11 and subsequent cruises was sex segregation--most males probably were in deeper water than where we fished pots.

We made 7 trips to sea during cruise 68-5 from May 7 to June 19, 1968. Pots were fished at night during all trips. Shrimp catches were very small with only 164 caught in pots at night during the cruise. None were caught during the day. Females were again predominant in pot catches during all trips (Figure 1). Of the 164 shrimp caught, 44 were males, 10 were transitional males; the rest were females. Midwater tow catches were predominantly males (Figure 2) of the 1966 and 1967 year classes. This is the strongest showing of the 1967 year/class males this year. It has been quite weak in both research (Figure 3) and commercial bottom catch samples during the period May through June, 1968. Sex composition fluctuated between 25 and 55% males for bottom tows. The mid-water trawl was towed 15

times during the cruise. A  $1\frac{1}{2}$ -inch mesh liner was sewn into the trawl prior to towing. Shrimp catches ranged from 0 to 8 pounds per  $\frac{1}{2}$ -hour tow.

The differences in sex composition between pot, midwater trawl, and bottom trawl catches probably indicate that: (1) a larger proportion of males than of females come off the bottom at night; (2) females were more attracted to (or retained better in) pots than males during the study period. This assumes no bias in midwater trawl catches toward males. The larger females, however, might avoid the net better.

It is difficult to explain why the shrimp ceased entering the pots during cruise 68-5. It was assumed during cruise 67-11 and 68-1 that the shrimp were entering in response to the ground fish. However, if this was true, then the shrimp have since changed feeding habits. Perhaps arrowtooth flounder have a hormone in their tissue during the fall and winter that is not present during the spring and summer. High pot catches were also associated with the shrimp spawning cycle. Female shrimp caught during October 1967 were beginning to form head roe. Catches began to fall off as gravidity decreased in March 1968. We could assume that during the late spring they did not come off the bottom at night but midwater trawl catches, day and night bottom catch rates, and those few shrimp caught in the pots all indicate that they were off the bottom. It is evident that they were not as strongly attracted to the bait during the late spring as during the fall and winter.

For all the problems we have presented, we do know that shrimp come off the bottom at night, often very rapidly, and go very high in the water column when the water is homothermous. This gives the shrimp a relatively rapid method for mass transport of movement via currents. This presents interesting possibilities for horizontal movement.

Although we attempted to correlate shrimp movements with moon phases, our data are not entirely adequate. Preliminary analysis of available data shows no correlation of moon phase with shrimp movements.

Gear problems were common throughout the cruises. As early problems were solved new ones cropped up. Pot losses were common throughout the study. On the first trip to sea (cruise 67-11) we lost several pots which snagged on the boat keel and broke loose. During trip 2 (cruise 67-11) we lost several pots because the attachment loops were twisting around the trolling clips and releasing the clips. Slight modifications of the clips corrected the problem. We did not lose any pots during cruise 68-1. However, during cruise 68-5 we lost 20 pots. Fifteen of these pots were lost during trip 1. New attachment loops were tied just prior to the trip. These loops were much shorter than those used previously. Apparently the shorter loops were subject to more chafing and as a result we lost many pots. The strings of pots were also lost for two nights during the trip due to currents. A detailed explanation is given in cruise report 68-5. Steel attachment rings were laced on the main lines to prevent further such losses. However, the rings also chafed and were sometimes broken or bent when they came through the line roller. Further losses occurred because of this

Buoy lights also caused troubles. Initially only one light was put on each halibut pole. On several occasions, however, the light went out and we were unable to locate the strings at night. Several things were done to rectify the problem; two lights were taped to each pole, batteries were used only one night and then replaced, screw threads in the lights were greased to prevent leakage, and the bulbs were retightened after each night of use.

Fog caused problems in locating the gear on trip 1 (cruise 68-1). Although we thought of putting radar reflectors on the poles, we did not encounter any more such trouble and dropped the idea. Future studies using similar buoy systems should definitely consider putting radar reflectors on each pole.

Pots constructed for the study were almost direct copies of those used in Alaska as described by McBride and Barr (1967) of BCF. We used  $\frac{1}{2}$ -inch diameter flexible polyethylene plastic pipe pressure tested to 125 pounds per square inch and nylon tees. Eighty pound test pipe and plastic tees were not suitable because the pipe tended to collapse with rough handling and the tees would break. The netting covering the pots was sewn together with nylon monofilament line supplied by a local upholstery shop. The pots, so constructed, were extremely resilient and stood up well under very rough handling.

Length-weight data were collected on cruises 67-11 and 68-1, and fecundity data was collected on cruise 67-11. In addition, length-weight data collected from market samples in 1963, 1964, and 1967 were worked up. Results of regression correlation were shown graphically



in quarterly reports for the second and third quarters of fiscal 1968 (quarterly report for October 1 - December 31, 1967; quarterly report for January 1 - March 31, 1968).

Observations in February and March, 1968, of aquarium-held pink shrimp caught with pots showed several interesting behavior patterns which may or may not be artificial. When first brought in and put in the aquarium, those shrimp near the inflow oriented themselves so that they either faced directly into or away from the current. This behavior broke down after a few weeks. The bottom of the aquarium was covered with calcite and shrimp made no attempt to burrow. Later approximately one half of the aquarium bottom was covered with sand. Again, shrimp made no attempt to burrow or cover up. Night observations showed increased shrimp activity in the form of swimming. An interesting phenomena occurred at night in that the pink or red shrimp coloration faded and the shrimp became almost transparent. Also at this time the eyes would glow with an orange-pink color. The transparent appearance and glowing eyes were also apparent during night operations at sea. Most of the shrimp held were gravid females. Zoea began to appear on February 23, 1968, and although they would settle to the bottom in still water, they were easily picked up and carried by the slightest current or eddy. The larvae did not seem to be very viable. No stage II zoea were observed. While the adult shrimp were held they were fed mostly minced clams. On one occasion they appeared to actively eat live nereid worms and were also observed picking and eating small barnacles.

An attempt was made to tag shrimp with dart tags inserted into the abdomen. However, shrimp so tagged all died within 1 to 6 days. The experiment was terminated on March 31, when the last shrimp died.

#### Literature Cited

##### Publications:

McBride, Roland, and Louis Barr. 1967. A shrimp pot for experimental fishing. J. Fish. Res. Bd. Can. 24:689-691.

##### Cruise Reports:

O.F.C. 67-4. August 30, 1967. Study on the vertical distribution and movement of pink shrimp, Pandalus jordani, in the Pacific Ocean off Oregon.

O.F.C. 67-8. September 19, 1967 "

O.F.C. 67-10. October 19, 1967 "

O.F.C. 67-11. January 9, 1968 "

O.F.C. 68-1. June 6, 1968. "

O.F.C. 68-2. April 16, 1968. Investigation of the abundance and recruitment of bottomfish off Oregon, with emphasis on Dover sole.

O.F.C. 68-5 (Being processed). Study on the vertical distribution and movement of pink shrimp, Pandalus jordani, in the Pacific ocean off Oregon.

##### Quarterly Reports:

O.F.C. January 5, 1968. Study on the vertical distribution and movement of pink shrimp. Pandalus jordani, in the Pacific ocean off Oregon.

O.F.C. April 4, 1968. "

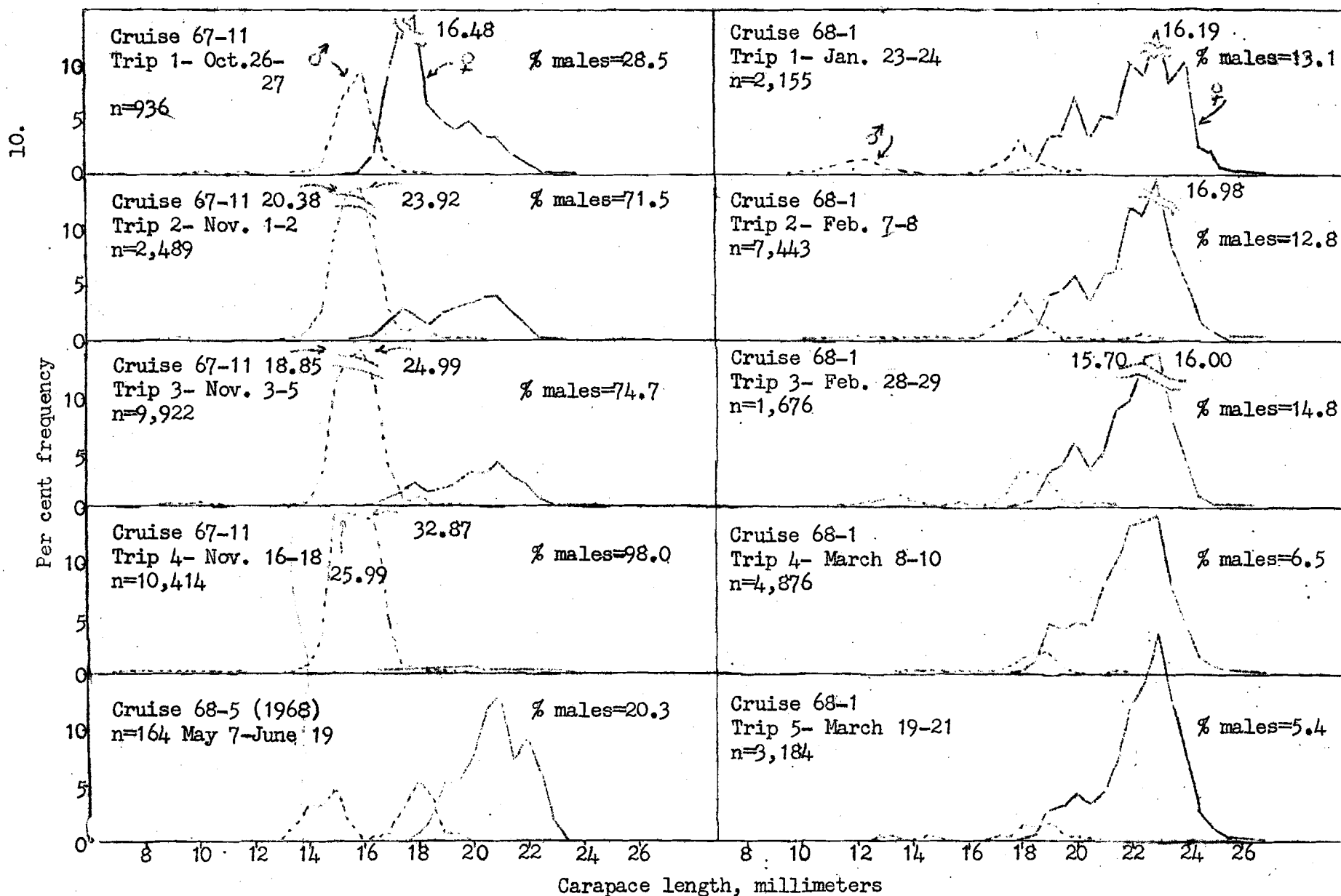


Figure 1. Length-frequency for Pot Catches by Cruise, Trip, and Sex

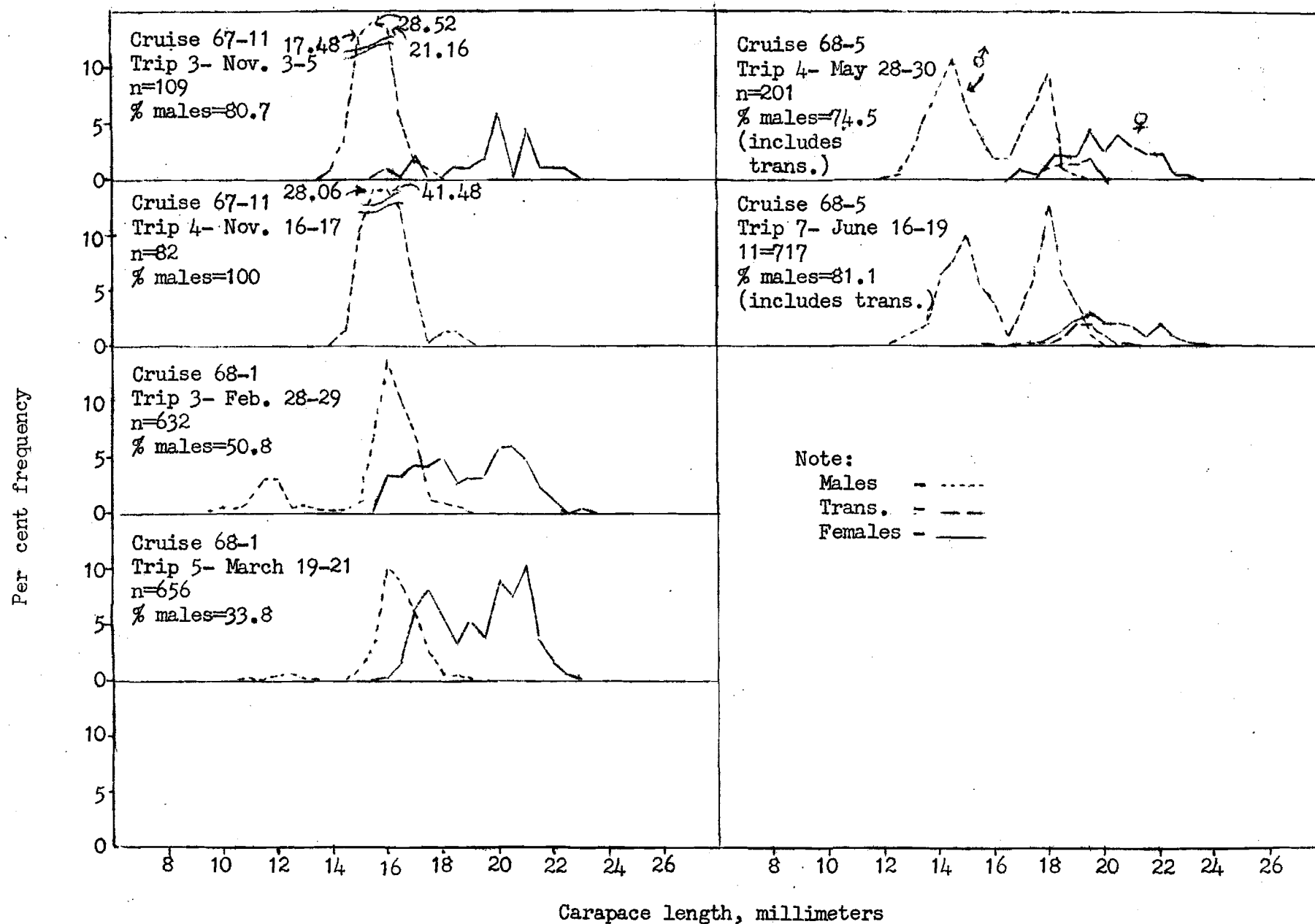


Figure 2. Length-frequency for Midwater Trawl Catches by Cruise, Trip, and Sex

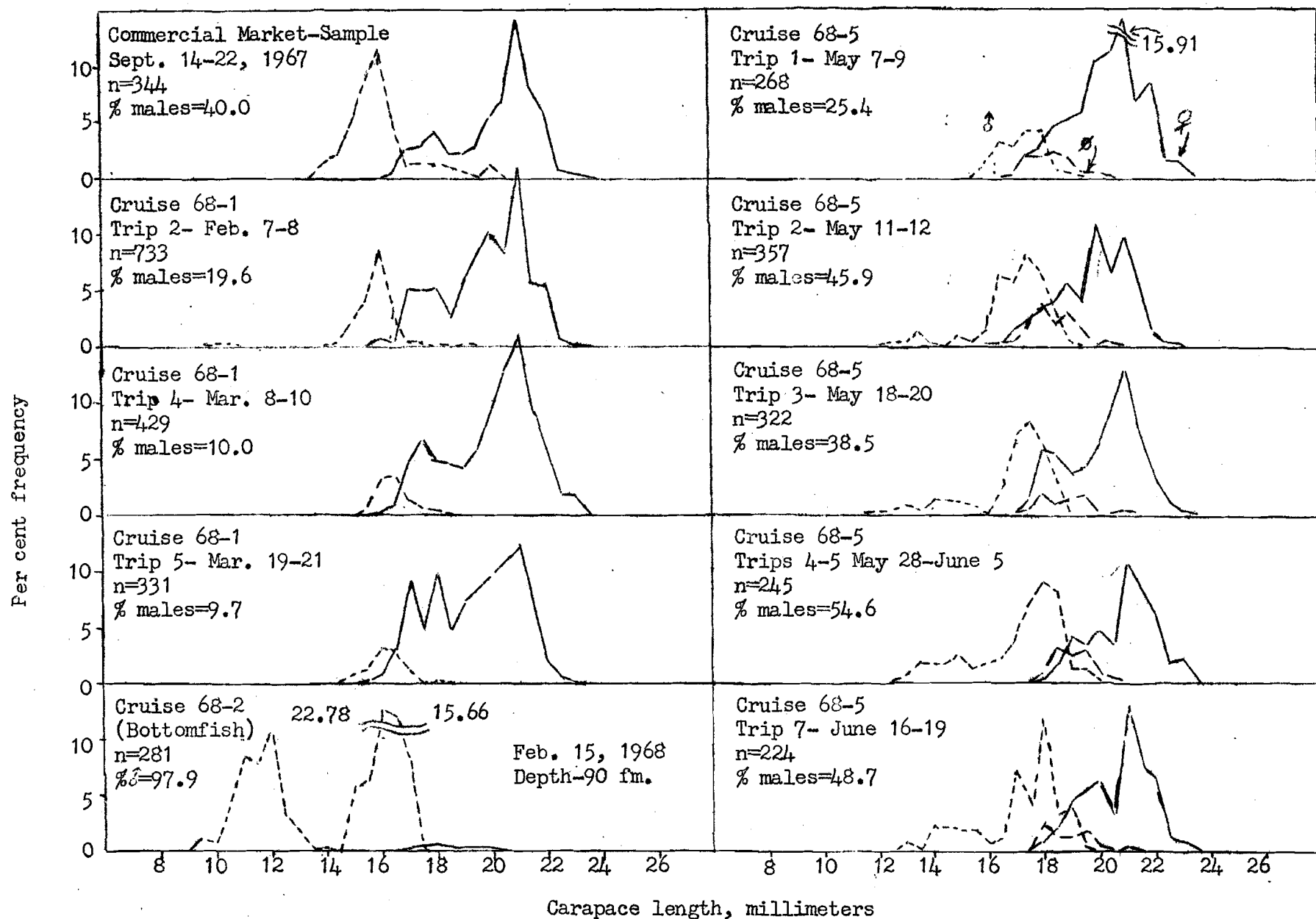


Figure 3. Length-frequency for Bottom Tow Catches by Cruise, Trip, and Sex