INFORMATION ON DIFFERENCES IN GROUNDFISH CATCH ESTIMATES
MADE BY OBSERVERS AND THOSE REPORTED BY VESSELS

by

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Contents

1. Discrepancies between ship's estimates of groundfish catch and estimates of catch by U.S. observers aboard Japanese stern trawlers. Robert French


Introduction

During 1973 and 1974 the government of Japan permitted U.S. scientists and technicians (and Canadian nationals through the International Pacific Halibut Commission) aboard Japanese vessels engaged in the eastern Bering Sea trawl fishery. The principal objectives of these observers were to obtain estimates of the incidence of halibut and crab in this fishery. From March 1973 through December 1974, observers were aboard 32 Japanese fishing vessels; either motherships or independent stern trawlers.

Often on the stern trawlers the observers were able to monitor complete trawl hauls for the incidence of halibut and crab; estimates of the number of tons that were landed in each haul and monitored were provided by the ship's officers. On six of the stern trawlers the observers at various times also made estimates of the number of tons in a haul which could be compared with the ship's estimate of the catch. It was apparent to the observers that their estimates were generally greater than those of the ship's officers. This report summarizes data on comparisons of the two estimates of landed tonnage and the impact of the different estimates on reported catches.

Methods of estimating catch tonnage

To obtain estimates of the catch of individual trawl hauls the observer determined the volume of fish in the receiving bins into which codends were
emptied. The volume in cubic meters was converted to weight using various conversion factors as determined by the observer. The average weight of a cubic meter of fish as measured by observers from several samples varied from .75 MT to about one metric ton. Two observers found that a measured volume of fish was close to the density of sea water--1.026 MT/m$^3$. It was recognized that the weight of a cubic meter of fish varies according to species and size of fish, the depth from which they are taken, and how well they pack in the basket, which was subsequently weighed.

The ship's officers obtained estimates of the weight of each trawl haul for their records of landed catch. These estimates were generally derived on the basis of many years of experience and probably involved several estimating techniques. According to observers on the stern trawlers, the estimates of weights were usually made by observing the net as it was brought aboard and emptied of its load. On some vessels the ship's officer or factory manager would go to the bin area to estimate the catch. These estimates were written on special forms provided by the observers and were given to the observers the day following the landings. Estimates of catch tonnage by ship's personnel and the observers were always made independently of each other. Whereas the ships' records were provided to the observer and also were the basis the catch data provided the Japan Fisheries Agency, the observers' estimates of catch were kept confidential.

Estimates of individual trawl hauls could not be obtained on motherships except by estimating the weight of individual codends as they were dumped into receiving bins. Generally the bins were full or partially full of fish, thus eliminating any chance to determine the volume and weight of an individual haul for comparison with ship estimates in the manner accomplished on stern trawlers.
Results

Comparison of observer and vessel personnel estimates of catches aboard stern trawlers showed some striking differences (Table 1). Of 341 comparisons summarized for six stern trawlers, the estimate of tonnage landed for various hauls by ships' personnel averaged about .77 of that estimated by observers.

The array of the ratios (ship's estimate/observer's estimate) is shown in Figure 1 and the frequency distribution of the ratios is given in Table 2. The geometric mean of the ratios is .7843 with 95% confidence limits of .7600 to .8073. The arithmetical mean is .8155 with the 95% confidence limits .7893 to .8418.

Examination of the distribution of the ratios greater than, or less than, the 1:1 ratio according to amount of catch (Table 3) indicates no appreciable trend with amount of catch. Because no appreciable trend is indicated, the single ratio value of .7843 best represents the difference between ships' estimates of catch and the observers' estimates.

This ratio value indicates, therefore, that ships' personnel underestimated the catch. A better estimate of the catch is to increase the ship's by 28 percent (i.e. 1/.7843 = 1.28). Data on the differences in catch estimates for each vessel are summarized below.

Yamato Maru  App. Table A-1

The observer on the Yamato Maru recorded the largest average difference from the ship's estimate of tonnage of the six vessels on which comparisons were made. His estimate for 32 comparisons was 61% higher than the ship's estimate for the same hauls. The ratio (ship's estimate/observer's estimate) for all comparisons was .62 and ranged from .20 to .80. This observer measured the bin volume and converted volume of fish to metric tons using a factor of 1 cubic meter equals 1 MT. The conversion factor was derived by weighing several baskets of fish and comparing the weight against the weight of an equal amount of sea water.
Figure 1.--Plot of ratios (ship's estimate/observer's estimate) of 341 comparisons of the catch in MT of Japanese stern trawlers.
Table 1. - Comparisons of ratios of ship's estimate to observer's estimate of catch for six stern trawlers of the Japanese trawl fleet, 1973-1974.

<table>
<thead>
<tr>
<th>Vessel Sample Number</th>
<th>Number of Comparisons</th>
<th>Ship's Estimate (MT)</th>
<th>Observer's Estimate (MT)</th>
<th>Ship's Estimate/Observer's Estimate Avg.</th>
<th>Range</th>
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<td>977.0</td>
<td>1,577.0</td>
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<td>.20 - .80</td>
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<tr>
<td>2</td>
<td>38</td>
<td>580.5</td>
<td>792.3</td>
<td>.73</td>
<td>.34 - 1.67</td>
</tr>
<tr>
<td>3</td>
<td>62</td>
<td>1,650.0</td>
<td>1,845.0</td>
<td>.89</td>
<td>.34 - 2.38</td>
</tr>
<tr>
<td>4</td>
<td>90</td>
<td>1,773.5</td>
<td>2,375.5</td>
<td>.75</td>
<td>.50 - 2.00</td>
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<tr>
<td>5</td>
<td>96</td>
<td>1,865.0</td>
<td>2,336.5</td>
<td>.80</td>
<td>.40 - 1.67</td>
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<tr>
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<td>23</td>
<td>898.0</td>
<td>1,097.0</td>
<td>.82</td>
<td>.51 - 1.11</td>
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<td>TOTAL 6</td>
<td>341</td>
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<td>10,023.3</td>
<td>.77</td>
<td>.20 - 2.38</td>
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Table 2. -Frequency distribution of ratios: ship's estimate of tons in a haul/observer's estimate.

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<tr>
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<td>1.45</td>
</tr>
<tr>
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<td>1.50</td>
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<td>1.63-1.67</td>
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<tr>
<td>1.98-2.12</td>
<td>2.00</td>
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<tr>
<td>2.38-2.42</td>
<td>2.40</td>
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| Total Frequency | 341 |

Summary

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<tr>
<td>St. Dev.</td>
<td>.2462</td>
</tr>
<tr>
<td>95% Confidence Interval</td>
<td>.7893-.8416</td>
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<tr>
<td>Geometric mean</td>
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</tr>
<tr>
<td>St. Dev.</td>
<td>.1229</td>
</tr>
<tr>
<td>95% Confidence Interval</td>
<td>.7603-.807</td>
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</tbody>
</table>


Table 3. —Distribution of ratios (ship's estimate/observer's estimate) above and below the 1:1 line according to amount of catch, and geometric means

<table>
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<tr>
<th>Tons</th>
<th>Number Greater than 1:1</th>
<th>Number Less than 1:1</th>
<th>Geometric Mean</th>
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</thead>
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<td>16</td>
<td>29</td>
<td>.766</td>
</tr>
<tr>
<td>6-10</td>
<td>4</td>
<td>39</td>
<td>.776</td>
</tr>
<tr>
<td>11-15</td>
<td>9</td>
<td>34</td>
<td>.771</td>
</tr>
<tr>
<td>16-20</td>
<td>6</td>
<td>42</td>
<td>.786</td>
</tr>
<tr>
<td>21-25</td>
<td>2</td>
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<td>26-30</td>
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<td>.773</td>
</tr>
<tr>
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<td>3</td>
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<td>.822</td>
</tr>
<tr>
<td>36-40</td>
<td>2</td>
<td>18</td>
<td>.800</td>
</tr>
<tr>
<td>41-45</td>
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<td>.793</td>
</tr>
<tr>
<td>46-50</td>
<td>1</td>
<td>12</td>
<td>.772</td>
</tr>
<tr>
<td>51-55</td>
<td>1</td>
<td>5</td>
<td>.803</td>
</tr>
<tr>
<td>56-60</td>
<td>0</td>
<td>5</td>
<td>.774</td>
</tr>
<tr>
<td>61-65</td>
<td>0</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>66-70</td>
<td>0</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>71-75</td>
<td>0</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>76-80</td>
<td>0</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>81-85</td>
<td>0</td>
<td>2</td>
<td>—</td>
</tr>
</tbody>
</table>
The largest differences arose when on 2 occasions the ship's estimates were 5 tons and the observer's estimates were 25 and 13 MT. It may be that the ship officers traditionally round relatively small catches to 5 tons thus creating large differences when the observer estimates the catch on the basis of volume. For all comparisons the observer's estimate of catch was substantially greater than the ship's estimate.

Zuiyo Maru #3 App. Table A-2

From a total of 38 comparisons the ratio of ship's to observer's estimate was .73 indicating the U.S. observer estimated 37% larger tonnage than recorded by the ship's officers for the same hauls. The range in ratios of the two estimates of catch was .34 to 1.67.

On this vessel the observer carefully determined the volume for various heights within the bin and estimated the volume of fish observed in the bins for the various hauls. Volume was converted to metric tons using a conversion factor of .75 MT per cubic meter of fish which was determined from basket samples. This conversion factor of .75 MT per cubic meter of fish was the lowest conversion factor derived from the several estimates made aboard the vessels.

The observer stated that ship's officers estimated the tonnage at haul from the mean weight of 100 pollock and the volume occupied by the fish. It is not known if the average weight of pollock was determined daily. The observer was of the opinion that the ship's estimate of tonnage was fairly consistent be it high or low from true values.

The largest discrepancies between ship's and observer's estimates, greater than 120% difference, occurred when catches were relatively small, 3 tons or less as estimated by the ship's officers.
The observer on the Hoyo Maru, in his estimates of catch tonnage, was closest to the estimates made by the ship's officers of the six vessels in which comparisons were made. In 62 comparisons the observer's estimated catch averaged 11% larger than that of the ship's officers (ship's/observer's ratio of .90). The ratios ranged from .34 to 2.38. The observer measured the volume of the bins and estimated the volume of fish landed for various hauls. He converted cubic meters of fish to tons using average weights as obtained from basket samples. The conversion factor used was not recorded.

The captain or chief officer determined the catch for each haul to the nearest 5 MT by a simple visual estimate of the net as it came aboard. The observer stated that catches in excess of 50 tons were recorded in the log as 50 MT to discourage other ships from converging on that particular area. The observer believed that total catches reported to the Japan Fishery Agency were underestimated. When the observer asked why the actual catch statistics weren't reported, the officer replied, "we don't care how much the catch is, we are only interested in the production from the catch".

The greatest discrepancies between the two estimates generally occurred when relatively small catches of about 5 MT were landed. It is likely that the ship officers rounded all small catches to 5 MT whereas the observer estimated the catches as accurately as possible from observations of bin volume of fish. The large difference of 192% was recorded when the 5-ton catch estimated by the officers was measured as 14.6 tons by the observer.

A total of 90 comparisons was made on the Haruna Maru between the observer's estimate of tonnage and the ship's estimate. The ratio of ship's
estimate to observer's estimate was .75 and ranged from .50 to 1.50 for
individual comparisons. As was noted in other observer reports, the
greatest discrepancy between estimates arose in estimating the weight of
relatively small catches.

Catch estimates by the ship's officers on the Haruna Maru were made
from direct observation of the net at haul. The observer thought these
estimates were extremely variable and usually lower than actual weight
figures.

The observer estimated the weight of various hauls by computing the
volume of fish in the bins and converting to weight. From several basket
samples of fish the observer found a cubic meter of fish to weigh .948 MT
and this conversion factor was used for all weight estimates.

Akebono Maru #72  App. Table A-5

The observer made 96 comparisons of the ship's estimate of tonnage for
a haul and his own estimate. The overall ratio of ship's estimate to observer's
estimate was .80 indicating the observer's estimate was 25% greater than the
captain's estimate for the same hauls. The range in ratios was .30 to 1.67
for individual hauls. The extreme difference arose when the captain's
estimate of 3 tons for one haul was recorded as 10 tons by the observer
from measurements of the catch in the bin.

The observer's estimate of catch was derived by determining the volume
of the catch in the bins and converting to weight. A conversion factor of
1.026 MT/m³ of fish (the density of sea water) was used to convert volume
to weight. This conversion factor was checked by obtaining the average
weight of 40 baskets of fish, determining the number of "cubic baskets"
in a bin and multiplying by the average weight of the baskets. The two
estimates were within a ton in estimating a bin capacity.
The captain of the Akebono Maru #72 estimated weight of the catch from observations of the net at haul. When the observer questioned the captain on how he estimated tonnage, the captain replied, "20 years experience".

Tenyo Maru App. Table A-6

On the Tenyo Maru the observer was given the bin capacity in tons by the ship's personnel from which he estimated the weight of various hauls. The ratio between the depth of fish when the bins were full to the depth of fish for a given haul was used to derive the estimated tonnage of that haul. For 22 comparisons of weight of catch the observer's estimate was 22% higher than the ship's estimate (ship's/observer's estimate of .82). The range in ratios was .51 to 1.11.

The ship's estimate of tonnage on the Tenyo Maru was supplied to the bridge by the factory manager. His estimates came from observations of the net at haul or the fish bins after the codend was emptied.

Impact of underestimated catches

The impact of underestimated tonnage of trawl landings can be understood from the following catch adjustments. In 1973 Japan reported a groundfish catch in the eastern Bering Sea of 1,688,297 MT for the mothership fishery and North Pacific trawl fishery. Of this total the independent stern trawlers accounted for 549,835 MT or 32.6% of the total.

On the basis of the observer reports the stern trawler catches may have been underestimated by an average of about 28 percent. After adjusting the catch for underestimated landings, we arrive at an adjusted catch of about 703,789 MT for the stern trawlers.
We do not have data on comparative estimates between observers and ship personnel for mothership landings, but if catches were underestimated on motherships in the same order of magnitude as on stern trawlers, adjusted catch totals would be much greater than reported. The catch for 1973 would be on the order of 2,161,020 MT instead of the reported 1,688,297 MT.

<table>
<thead>
<tr>
<th>Date</th>
<th>Haul No.</th>
<th>Ship's estimate Mt.</th>
<th>Observer's estimate Mt.</th>
<th>Ratio: Ship's estimate/observer's estimate</th>
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Total: 977  1,577  .62

No. of comparisons: 32
Range in ratios: .20 to .80
Appendix Table A-2. Observer's estimate of catch for certain hauls compared with catch estimates supplied by vessel officers, En'yo Maru #3, 1973.

<table>
<thead>
<tr>
<th>Date</th>
<th>Haul No.</th>
<th>Ship's estimate</th>
<th>Observer's estimate</th>
<th>Ratio: ship's estimate/observer's estimate</th>
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<td>Mt.</td>
<td>Mt.</td>
<td></td>
</tr>
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No. of comparisons: 62

Range in ratios: .34 to 2.38
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Range in ratios... .30 to 1.67
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</table>

No. of comparisons: 23
Range in ratios: .51 to 1.11
Discrepancies Between Ship and Observer Estimates of Groundfish Catch in the 1978 Japanese Stern Trawler Fishery

By

John Horton and Robert French

INTRODUCTION

With the passage of the Fisheries Conservation and Management Act of 1976 the United States increased its capacity to monitor and control foreign fishing effort in order to protect its marine resources. Before this act was implemented, much of the catch monitoring was conducted by a few observers placed aboard foreign fishing vessels with the permission of the particular government concerned. However, the Act enabled the United States to increase its observer coverage substantially.

One of the primary purposes of the U.S. observers has been the collection of data on the size of catch for individual trawl hauls. Also, observers have recorded estimates of catch size made by ship officers. During the first few years of the Foreign Observer Program, it has become evident that estimates of catch size by ship officers and observers differ substantially.

A 1976 study conducted by Robert French compared catch estimates made by observers and Japanese ship officers before the 200-mile legislation was passed. For purposes of comparison the present analysis was patterned after French's study. This report compares catch estimates obtained during the 1978 Japanese stern trawler fishery; analyzes the extent of estimate discrepancies; compares data trends for different vessel classes; and discusses the impact of discrepancies on catch statistics reported by foreign fleets.
METHODS

Several methods were used by observers and ship officers to obtain estimates of catch tonnage. Most of the estimates were obtained through either fish bin volume, codend, or production figure methods. Usually, the observer employed one of these methods throughout much of the cruise. For some cruises the observers and ship officers used several different methods.

For bin volume estimates the observer measured the area of the floor and walls of the fish holding bin (Figure 1). After each haul was dumped into a bin, the observer determined the height of fish in the bin. The height was multiplied by the appropriate area dimensions to obtain volume (cubic meters) for the haul. Catch weight was obtained by multiplying the haul volume by a density factor (mt/m$^3$). The observers usually derived their density factors by taking the average weight of several random basket samples. Sometimes the observers used density factors obtained by other observers on previous cruises. Ship officers based their bin estimates on measurements provided by either ship personnel or the observer. Occasionally the observer used area or volume measurements provided by ship personnel.

For codend estimates the observers determined the volume or weight of the fish that accumulated in the rear (codend) of the trawl net. The construction of these nets included regularly spaced bands or horizontal support straps that strengthened the mesh during heavy hauls. After the haul was brought aboard, the observer counted the number of bands and determined the volume of catch between two bands. If codend measurements could not be obtained, the observer would use an estimate of volume or weight per band provided by the ship officers. Extrapolation for the total number of band segments gave the haul volume. The haul volume was then multiplied by a density factor to obtain haul weight (Figure 2).
The observers and ship personnel often based their estimates on production figures from the ship's processing factory. Generally, the observer or ship personnel would determine the relationship between the amount of fish processed and the amount of product obtained. Then the average conversion would be applied to the total production to obtain an estimate of haul weight. Sometimes production conversion factors were used to adjust bin or codend estimates.

During 1978, U.S. observers monitored 100 cruises (8.1 percent coverage) made by Japanese stern trawlers in the Gulf of Alaska and the Bering Sea. Sixty-six of these cruises were analyzed in this study. Forty-seven cruises were made by small trawlers (ship weight less than 1499 tons). Nineteen cruises were made by large trawlers (ship weight greater than 1499 tons).

The primary source of information for this analysis consisted of computer printouts which listed observer and ship estimates by haul and mean ship and observer estimates by cruise. Also, mean ship and observer estimates for each vessel class within each of the two areas were listed. The printouts only included hauls where the two estimates were made. Six of the 53 small trawler cruises in the printouts were eliminated due to the questionable validity of the data. Specific reasons for eliminating cruises included the lack of cruise reports, ambiguous reports, concern by the particular observer over validity, and questionable sampling schemes. Due to the elimination of these cruises, overall mean ship and observer estimates were calculated manually for the small trawler data. Further manual calculation produced ratios of the mean ship estimate to the mean observer estimate for each cruise, vessel type, and area (Appendix Tables A-1 and A-2). Where appropriate, the calculations were weighted by either the number of hauls or cruises.
Synopses describing estimation techniques and sampling problems for each cruise, which were prepared by NMFS personnel, were used in this study to evaluate trends in data.

RESULTS AND DISCUSSION

Data for the two vessel types should be considered separately for two reasons. First, the sampling situations differed. Second, the data trends, which were affected by more than the differences in sampling, differed for the two types of trawlers.

The sampling requirements for the two vessel types differed. Although determination of the statistical effects of these differences was beyond the scope of this study, their importance is indicated by the following example. Observers on the small trawlers sometimes had to devise alternative sampling techniques to accommodate the peculiarities of ship structure and operation. For example, the crew occasionally changed the arrangement of the boards comprising the fish bins. Such changes altered the shape of the bins. The sampling adjustments necessitated by these changes could have conceivably introduced some bias into the data that would not have been encountered as much on large trawlers with stable bin dimensions. More information concerning sampling error in general is given later in this paper.

Data trends for the Bering Sea and Gulf of Alaska differed for the two vessel types. The ratio of the mean ship estimate to the mean observer estimate (Table 1) showed a larger difference between the two areas for large trawlers (ratio of .81 for the Bering Sea; .96 for the Gulf of Alaska). The ratios did not differ much between the two areas for small trawlers (ratio of .68 for the Bering Sea; .64 for the Gulf of Alaska). However, inferences about the two areas are limited since 7.5 times more trawl hauls occurred in the Bering Sea.
than in the Gulf of Alaska. Until more data for other years is analyzed for the Gulf of Alaska, it would be wise to pool the area data for the separate vessel types. The overall weighted ratio for the two areas for small trawlers was .67. For large trawlers the overall weighted ratio was .81.

The ratio data for the small trawlers "centered" around the high .60's and the low .70's. Approximately half of the cruise ratios fell below .70 (Table 4 and Figure 3). Also, the largest number of cruises (approximately 19 percent) had cruise ratios within the .60 to .69 range. Consequently, the overall ratio of .67 for the small trawlers is supported by these trends. If the observer data is used as a standard, such a ratio would denote 49 percent underestimation by the Japanese small trawler fishery.

The cruise ratios for the large trawlers grouped around the .60's and the .90's (Table 5 and Figure 4). The overall ratio was .81 (Table 1). French's study dealing with large trawlers showed similar results. For 341 haul comparisons he obtained a mean ratio of .8155. For the present study, if the observer data is used as a standard, the derived ratio denotes 23 percent underestimation by the Japanese large trawler fishery.

For the small trawlers the differences in the estimates became larger as catch size increased (Table 2). For example, most of the cruises had a mean tonnage per haul (observer's estimated tonnage) between 2 and 4 metric tons (MT). For this tonnage category the mean cruise ratio, which was weighted by the number of hauls within the cruises, was .75. The ratio dropped to .36 for catches above 6 MT. Although the trend went toward less agreement, it should be noted that the sample sizes (number of cruises) were usually smaller for large catches.
For the large trawlers the differences in the estimates also became larger as catch size increased (Table 3). However, the decrease in the ratio of the ship to observer estimate was not as dramatic. For example, most of the cruises had a mean tonnage per haul between 30 and 40 MT. The weighted mean ratio for this tonnage category was .84. The lowest ratio in the higher categories, .55, only represented a decrease of 29 percent. For the small trawler example, the decrease was 39 percent. Thus, for the large trawlers, which made larger catches than the small trawlers, the agreement was better. Apparently, the data indicates that the trend of decreasing agreement with increasing catch size remains strong within the separate vessel classes, but would falter if the data were combined. The possible causes of this phenomenon are discussed later in this paper.

The differences between the two vessel types are not apparent when the data is combined (Table 6). The combined data generally resembles the large trawler data (Table 5), but does not reflect important aspects of the small trawler data. For example, for the combined data many of the cruise ratios fell in the .60 to .69 interval. However, three-fourths of these ratios were for small trawlers. Also, the combined data does not reflect the different levels of agreement for the two vessel types. For example, 80 percent of the small trawler ratios, but only 42 percent of the large trawler ratios fell below .90 (Tables 4 and 5). These data trends, in addition to the 14 percent difference between the overall ratios for the two trawler classes, indicate that future studies should consider the two classes separately.

Factors causing differences in estimates

Several sources of error influenced the catch estimates. The following summary includes observations obtained through the use of report synopses and discussions with NMFS personnel concerning sampling error on foreign vessels.
For bin volume estimates, the observer usually obtained his density factors by weighing basket samples or using relationships derived by other observers. French (1976) indicated the weight of a basket sample may vary according to factors such as species and size of the fish, depth from which the fish are taken, different packing arrangements, and density of the fish. The density factors used by observers and ship officers often differed. Usually, the ship's factor was lower. Consequently, these lower factors would have resulted in a smaller catch estimate by the ship officers. For example, the observer on the Haruna Maru (Cruise 225) used density factors that ranged from .90 to .96 m³/m³. The ship officers used .8 m³/m³ as the "standard" density factor. Other ships also used standard density factors. Of course, applying a standard factor does not take into account the variability revealed by French's study.

Variation in bin measurements may have been reflected in the data. Occasionally, bin measurements made by the observers and ship personnel differed. Furthermore, the rolling of the ship sometimes caused difficulty in determining the height of fish in the bin. Several of the small trawlers had irregularly shaped bins which made bin measurements difficult to determine accurately. Also, in the course of their operations, the crew occasionally changed the shape of the bins by rearranging the boards that comprised the walls.

Codend estimates were influenced by several factors. Fish in the bottom of the net may have been compressed to the extent that volume determinations would have been inaccurate. Also, the various shapes of the net would have made volume determination difficult.

Differences in the production conversion factors used by observers and ship officers resulted in different catch estimates. For example, the observer on the Yakushi Maru No. 31 (Cruise 227) computed an average recovery rate of .65 for Greenland turbot while the ship used .8. The higher conversion factor would have resulted in lower catch estimates by the ship officers.
The different estimation techniques used by observers and ship officers for the same hauls may have introduced some variation into the estimates. For example, the observer on the *Shinei Maru No. 21* (Cruise 231) used a density factor expansion while the captain used a conversion factor to expand the production figures. Several other observers used bin estimates while the ship officers used codend estimates. Further study may reveal the extent of the discrepancies caused by these practices.

Another factor to consider in the accuracy of estimation is the experience of the estimator. It is conceivable that observer estimates became more accurate as the observers familiarized themselves with shipboard estimation. The experience of the ship officers also varied. The observer on the *Tora Maru No. 31* (Cruise 182) reported that the captain did not know how to estimate total catch during the first part of the cruise. The observer explained the procedure to the captain and this procedure was used by both estimators during much of the remainder of the cruise.

An important cause of the differences was the widespread practice among the ship officers of excluding unutilized species and waste from their catch estimates. Twenty of the 47 observers on the small trawlers reported that the ship officers either did not count the unutilized species or used an arbitrary correction factor for these species. The synopses of the observer reports did not indicate whether any estimates of the unutilized portion were made. However, further study of other reports and data may lead to an estimate.

The differences may have been affected by the extent of the captain's knowledge concerning the observer's estimates. Generally, the observers kept their estimates confidential. However, in a few cases the captain was aware that the observer was making a separate estimate. For example, the captain and the observer on the *Daito Maru No. 38* (Cruise 178) compared estimates and reached a compromise.
On the Tomi Maru No. 85 (Cruise 218) the ship officers used production figures during the first part of the cruise, but after noticing large discrepancies in the two estimates they used methods similar to the observer's procedures. Rounding may have introduced bias into the catch estimates. Since the observer reports usually did not include information on rounding by the observer or the ship officers, it was difficult to determine the particular rounding procedures used for each cruise. Consequently, the possible lack of standardization of rounding may have affected the estimates. French (1976) believed that some ship officers traditionally round small catches to 5 tons. Also, French reported that one ship recorded catches in excess of 50 tons as 50 tons to discourage other fishing vessels from discovering prime fishing areas. "Rounding" or the "ceiling effect" caused by such motives may have introduced some bias into the 1978 data. Catches in excess of 50 tons were taken during several of the large trawler cruises. As the catches became larger, the discrepancy became larger. The data for the Zuiyo Maru No. 3 (Cruise 232) seemed to be representative of these statements. The estimates up to 30 tons (observer estimate) differed by not more than 10 tons. Between 30 and 50 tons the estimates differed by not more than 16 tons. However, above 50 tons the estimates differed as much as 26 tons. Many of the cruises reflected this trend of greater discrepancy with larger hauls. Although this discrepancy may have been caused by other factors, it may be worthwhile to consider such motives in future studies.

Impact of underestimation

Underestimated catches had a significant impact on the reported landings for the 1978 Japanese stern trawler fishery. Table 7 gives the official totals by area and vessel type. Table 8 gives the adjusted totals. The adjusted totals (Table 8) were derived by multiplying each official total catch (Table 7) by its
corresponding inverse ratio (Table 1). For example:

\[
\frac{161351.1}{\text{Bering Sea small trawler unadjusted total}} \times 1.48 = 238802.6 \text{ MT}
\]

(Adjusted catch in metric tons)

As was discussed earlier, the large and small trawler data should be considered separately. For the small trawler fishery the adjusted catch would be 261168.2 MT. The adjusted catch for the large trawler fishery would be 474513.1 MT. Since the data trends for the separate areas were not distinct, this data was combined. Thus, the adjusted totals given above reflect the data combined by vessel class only. Since the data trends justify treating the vessel classes separately, the overall total obtained by adding the vessel class totals would differ from the overall total derived by adjustment of the combined data. Therefore, the overall total, which differs from the Table 8 total, would be 735681.3 MT. The unadjusted total of 561063.7 MT differs from this total by 174617.6 MT.

Recommendations for future studies

Future studies on catch estimates would benefit from more detailed information on the frequency of use of the different types of estimates. Observers should be required to report the specific estimation procedure used for each haul. Also, it would be helpful if such information for the ship estimates is collected.

In order to better determine the effects of variation within and between cruises, computer programs need to be developed that give ratios by haul, cruise, and vessel class. For example, the trend of decreasing agreement with increasing catch size can be studied in more detail if haul ratios rather than cruise ratios are provided. Another aspect needing further study is the weighting procedure for the summary statistics. The number of hauls or cruises was used for weighting in the present study because the computer printouts provided these
totals in a summarized format. If future computer programs would provide catch size for each cruise and vessel class in a readily usable format, then it would be interesting to see what effect, if any, weighting by catch size would have on the summary statistics.

Future studies should also consider four other factors that may cause extensive variation in the data. First, variations in density factors and their effect on estimate discrepancies should be studied. Second, the differences in estimates for the two areas should be studied. Since the lack of data for the 1978 Gulf of Alaska fishery limited the analysis by area, data for the Gulf should be combined with data from other years to make the analysis. Third, since the exclusion of unutilized fish played an important role in underestimation by the foreign fleet, observers should begin to devote more attention to the proportion of such species in the catches. Fourth, analyzes should be conducted for each company's ships to detect any discrepancies due to company policies dealing with estimation.

ACKNOWLEDGMENTS

I thank Bruce Gibbs of the National Marine Fisheries Service for providing the computer printouts used in this study. Russell Nelson and Robert French of the Foreign Observer Program provided valuable assistance during the study and offered numerous, useful suggestions for revision of the manuscript. I also thank M. Gregory for typing the manuscript.

Figure 1.—Fish holding bin. For bins with irregular shapes, the geometric components are measured separately and summed to obtain total area (National Marine Fisheries Service, 1979).
Figure 2.--Codend of a trawl net. The volume of fish within a band segment is extrapolated to the total volume of catch.
Figure 3.--Relationship of cruise ratios (mean ship/mean observer estimate) to catch size (in MT) for 47 Japanese small trawler cruises.
Figure 4.—Relationship of cruise ratios (mean ship/mean observer estimate) to catch size (in MT) for 19 Japanese large trawler cruises.
Table 1.--Summary of estimate comparisons by area and vessel class (data for the two areas were considered separately for cruises occurring in both areas).

<table>
<thead>
<tr>
<th></th>
<th>Number of hauls compared</th>
<th>Mean ship estimate</th>
<th>Mean observer estimate</th>
<th>Ratio Mean ship/Mean observer</th>
<th>Inverse ratio</th>
<th>Range of cruise ratios</th>
</tr>
</thead>
<tbody>
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<td><strong>Bering Sea</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>1002</td>
<td>30.802</td>
<td>38.168</td>
<td>.81</td>
<td>1.24</td>
<td>.55 - 1.04*</td>
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<tr>
<td>Small</td>
<td>2486</td>
<td>2.026</td>
<td>2.997</td>
<td>.68</td>
<td>1.48</td>
<td>.31 - 1.01</td>
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<tr>
<td><strong>Gulf of Alaska</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>43</td>
<td>27.790</td>
<td>28.891</td>
<td>.96</td>
<td>1.04</td>
<td>.96 (one cru)</td>
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<tr>
<td>Small</td>
<td>424</td>
<td>2.042</td>
<td>3.178</td>
<td>.64</td>
<td>1.56</td>
<td>.36 - 1.00**</td>
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<tr>
<td><strong>Bering Sea (overall)</strong></td>
<td>3488</td>
<td>10.293</td>
<td>13.101</td>
<td>.79</td>
<td>1.27</td>
<td>.31 - 1.04*</td>
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<tr>
<td><strong>Gulf of Alaska (overall)</strong></td>
<td>467</td>
<td>4.413</td>
<td>5.546</td>
<td>.80</td>
<td>1.26</td>
<td>.36 - 1.00**</td>
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<td><strong>Both areas</strong></td>
<td>3955</td>
<td>9.599</td>
<td>12.209</td>
<td>.79</td>
<td>1.27</td>
<td>.31 - 1.04*</td>
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<tr>
<td>Large trawlers</td>
<td>1045</td>
<td>30.678</td>
<td>37.786</td>
<td>.81</td>
<td>1.23</td>
<td>.55 - 1.04*</td>
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<tr>
<td>Small trawlers</td>
<td>2910</td>
<td>2.028</td>
<td>3.023</td>
<td>.67</td>
<td>1.49</td>
<td>.31 - 1.01</td>
</tr>
</tbody>
</table>

* 1.04 = ratio for Bering Sea portion of a cruise that crossed both areas.
** 1.00 = ratio for Gulf of Alaska portion of a cruise that crossed both areas.
+ 43 out of 56 hauls for Cruise 249 were in the Gulf of Alaska.
Table 2.--Relationship of cruise ratios to catch size for 47 Japanese small trawler cruises (mean ratios weighted by number of hauls within each cruise).

<table>
<thead>
<tr>
<th>Mean observer estimate (MT)</th>
<th>No. of cruise estimates</th>
<th>No. greater than 1:1</th>
<th>No. less than 1:1</th>
<th>Weighted mean ratio</th>
<th>Range of unweighted ratios</th>
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<tbody>
<tr>
<td>0 - 2.0</td>
<td>10</td>
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<td>10</td>
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<td>.53 - .96</td>
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<td>2.1 - 4.0</td>
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<td>0</td>
<td>25</td>
<td>.75</td>
<td>.49 - .95</td>
</tr>
<tr>
<td>4.1 - 6.0</td>
<td>8</td>
<td>1</td>
<td>7</td>
<td>.66</td>
<td>.40 - 1.01</td>
</tr>
<tr>
<td>6.1 - 8.0</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>.36</td>
<td>.31 - .39</td>
</tr>
<tr>
<td>8.1 -10.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10.1 -12.0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>.36</td>
<td>.36</td>
</tr>
</tbody>
</table>

Table 3.--Relationship of cruise ratios to catch size for 19 Japanese large trawler cruises (mean ratios weighted by number of hauls within each cruise).

<table>
<thead>
<tr>
<th>Mean observer estimate (MT)</th>
<th>No. of cruise estimates</th>
<th>No. greater than 1:1</th>
<th>No. less than 1:1</th>
<th>Weighted mean ratio</th>
<th>Range of unweighted ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1 - 20.0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>.999</td>
<td>.999</td>
</tr>
<tr>
<td>20.1 - 30.0</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>.94</td>
<td>.89 - 1.004</td>
</tr>
<tr>
<td>30.1 - 40.0</td>
<td>8</td>
<td>1</td>
<td>7</td>
<td>.84</td>
<td>.57 - 1.00019</td>
</tr>
<tr>
<td>40.1 - 50.0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>.85</td>
<td>.64 - 1.012</td>
</tr>
<tr>
<td>50.1 - 60.0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>.55</td>
<td>.55</td>
</tr>
<tr>
<td>60.1 - 70.0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>.72</td>
<td>.68 - .77</td>
</tr>
</tbody>
</table>
Table 4.—Frequency distribution of mean ratios for 47 Japanese small trawler cruises (Range: .31 - 1.01).

<table>
<thead>
<tr>
<th>Interval</th>
<th>No. of cruises</th>
<th>Percent of total</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>.30 - .39</td>
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<td>8.51</td>
<td>8.51</td>
</tr>
<tr>
<td>.40 - .49</td>
<td>6</td>
<td>12.77</td>
<td>21.28</td>
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<tr>
<td>.50 - .59</td>
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<td>10.64</td>
<td>31.92</td>
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<tr>
<td>.60 - .69</td>
<td>9</td>
<td>19.15</td>
<td>51.07</td>
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<tr>
<td>.70 - .79</td>
<td>7</td>
<td>14.89</td>
<td>65.96</td>
</tr>
<tr>
<td>.80 - .89</td>
<td>7</td>
<td>14.89</td>
<td>80.85</td>
</tr>
<tr>
<td>.90 - .99</td>
<td>8</td>
<td>17.02</td>
<td>97.87</td>
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<tr>
<td>1.00 - 1.09</td>
<td>1</td>
<td>2.13</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Total 47 100.00

Table 5.—Frequency distribution of mean ratios for 19 Japanese large trawler cruises (Range: .55 to 1.012).

<table>
<thead>
<tr>
<th>Interval</th>
<th>No. of cruises</th>
<th>Percent of total</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>.50 - .59</td>
<td>2</td>
<td>10.53</td>
<td>10.53</td>
</tr>
<tr>
<td>.60 - .69</td>
<td>3</td>
<td>15.79</td>
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<td>.80 - .89</td>
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<td>8</td>
<td>42.10</td>
<td>84.21</td>
</tr>
<tr>
<td>1.00 - 1.09</td>
<td>3</td>
<td>15.79</td>
<td>100.00</td>
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</table>

Total 19 100.00
Table 6.--Frequency distribution of mean ratios for 66 Japanese trawler cruises (Range: .31 to 1.012).

<table>
<thead>
<tr>
<th>Interval</th>
<th>No. of cruises</th>
<th>Percent of total</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>.30 -.39</td>
<td>4</td>
<td>6.06</td>
<td>6.06</td>
</tr>
<tr>
<td>.40 -.49</td>
<td>6</td>
<td>9.09</td>
<td>15.15</td>
</tr>
<tr>
<td>.50 -.59</td>
<td>7</td>
<td>10.61</td>
<td>25.76</td>
</tr>
<tr>
<td>.60 -.69</td>
<td>12</td>
<td>18.18</td>
<td>43.94</td>
</tr>
<tr>
<td>.70 -.79</td>
<td>8</td>
<td>12.12</td>
<td>56.06</td>
</tr>
<tr>
<td>.80 -.89</td>
<td>9</td>
<td>13.64</td>
<td>69.70</td>
</tr>
<tr>
<td>.90 -.99</td>
<td>16</td>
<td>24.24</td>
<td>93.94</td>
</tr>
<tr>
<td>1.00 -1.09</td>
<td>4</td>
<td>6.06</td>
<td>100.00</td>
</tr>
<tr>
<td>Total</td>
<td>66</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>
Table 7.—Summary of totals (MT) for Japanese stern trawler catches in the Gulf of Alaska and Bering Sea during 1978.

<table>
<thead>
<tr>
<th></th>
<th>Small trawler</th>
<th>Large trawler</th>
<th>Large + small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bering Sea</td>
<td>161353.1</td>
<td>348812.5</td>
<td>510165.6</td>
</tr>
<tr>
<td>Gulf of Alaska</td>
<td>13927.6</td>
<td>36970.5</td>
<td>50898.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>175280.7</strong></td>
<td><strong>385783.0</strong></td>
<td><strong>561063.7</strong></td>
</tr>
</tbody>
</table>

Table 8.—Revised totals for 1978 (each total adjusted separately).

<table>
<thead>
<tr>
<th></th>
<th>Small trawler</th>
<th>Large trawler</th>
<th>Large + small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bering Sea</td>
<td>238802.6</td>
<td>432527.5</td>
<td>647910.3</td>
</tr>
<tr>
<td>Gulf of Alaska</td>
<td>21727.1</td>
<td>38449.3</td>
<td>64131.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>261168.2</strong></td>
<td><strong>474513.1</strong></td>
<td><strong>712550.9</strong></td>
</tr>
</tbody>
</table>
Table A-1. Comparison of mean ship and observer estimates for 47 cruises in the 1978 Japanese small trawler fishery (B = Bering Sea; GOA = Gulf of Alaska).

<table>
<thead>
<tr>
<th>Cruise No.</th>
<th>Area</th>
<th>No. of hauls compared</th>
<th>Mean ship estimate</th>
<th>Mean observer estimate</th>
<th>Ratio</th>
<th>Inverse ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>126</td>
<td>B</td>
<td>113</td>
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<td>4.801</td>
<td>.76</td>
<td>1.31</td>
</tr>
<tr>
<td>131</td>
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<td>50</td>
<td>2.239</td>
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<td>.40</td>
<td>2.50</td>
</tr>
<tr>
<td>133</td>
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<tr>
<td>135</td>
<td>B</td>
<td>36</td>
<td>2.416</td>
<td>6.194</td>
<td>.39</td>
<td>2.56</td>
</tr>
<tr>
<td>137</td>
<td>B</td>
<td>96</td>
<td>.737</td>
<td>1.384</td>
<td>.53</td>
<td>1.88</td>
</tr>
<tr>
<td>139</td>
<td>GOA</td>
<td>31</td>
<td>2.803</td>
<td>3.523</td>
<td>.80</td>
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<tr>
<td>144</td>
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<td>2.533</td>
<td>2.839</td>
<td>.89</td>
<td>1.12</td>
</tr>
<tr>
<td>146</td>
<td>B</td>
<td>4</td>
<td>.300</td>
<td>.428</td>
<td>.70</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>GOA</td>
<td>107</td>
<td>1.843</td>
<td>2.490</td>
<td>.74</td>
<td>1.35</td>
</tr>
<tr>
<td></td>
<td>Both</td>
<td>111</td>
<td>1.787</td>
<td>2.416</td>
<td>.74</td>
<td>1.35</td>
</tr>
<tr>
<td>148</td>
<td>B</td>
<td>89</td>
<td>.892</td>
<td>1.396</td>
<td>.64</td>
<td>1.57</td>
</tr>
<tr>
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<td>71</td>
<td>1.919</td>
<td>2.649</td>
<td>.72</td>
<td>1.38</td>
</tr>
<tr>
<td>159</td>
<td>GOA</td>
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<td>1.996</td>
<td>.65</td>
<td>1.55</td>
</tr>
<tr>
<td>160</td>
<td>B</td>
<td>14</td>
<td>3.321</td>
<td>3.678</td>
<td>.90</td>
<td>1.11</td>
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<tr>
<td>162</td>
<td>B</td>
<td>104</td>
<td>1.988</td>
<td>2.152</td>
<td>.92</td>
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<tr>
<td>163</td>
<td>B</td>
<td>75</td>
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<td>3.063</td>
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<td>1.65</td>
</tr>
<tr>
<td>165</td>
<td>B</td>
<td>79</td>
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<td>.905</td>
<td>.90</td>
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<td>167</td>
<td>B</td>
<td>50</td>
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<td>2.425</td>
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<tr>
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<td>B</td>
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<td>.83</td>
<td>1.21</td>
</tr>
<tr>
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<td>86</td>
<td>4.485</td>
<td>4.438</td>
<td>1.01</td>
<td>.99</td>
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<tr>
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</tr>
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<td>79</td>
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<td>.43</td>
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</tr>
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<td>79</td>
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<td>2.04</td>
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<td>2.134</td>
<td>5.177</td>
<td>.41</td>
<td>2.43</td>
</tr>
<tr>
<td>237</td>
<td>GOA</td>
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<tr>
<td>Cruise No.</td>
<td>Area</td>
<td>No. of hauls compared</td>
<td>Mean ship estimate</td>
<td>Mean observer estimate</td>
<td>Ratio</td>
<td>Inverse ratio</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
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<td>--------------------</td>
<td>------------------------</td>
<td>-------</td>
<td>---------------</td>
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<tr>
<td>243</td>
<td>B</td>
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<td>2.753</td>
<td>6.994</td>
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<td>2.54</td>
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<tr>
<td>244</td>
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<tr>
<td>246</td>
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<td>1.363</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
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<td>1.636</td>
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</tr>
<tr>
<td>250</td>
<td>B</td>
<td>40</td>
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<td>6.255</td>
<td>.31</td>
<td>3.21</td>
</tr>
<tr>
<td>252</td>
<td>B</td>
<td>62</td>
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<td>.41</td>
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<td>Overall (47 cruises)</td>
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<td>.67</td>
<td>1.49</td>
</tr>
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<td>Bering Sea</td>
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<td>2.026</td>
<td>2.997</td>
<td>.68</td>
<td>1.48</td>
</tr>
<tr>
<td>Gulf of Alaska</td>
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<td>2.042</td>
<td>3.178</td>
<td>.64</td>
<td>1.56</td>
</tr>
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</table>
Table A-2.—Comparison of mean ship and observer estimates for 19 cruises in the 1978 Japanese large trawler fishery (B = Bering Sea; GOA = Gulf of Alaska).

<table>
<thead>
<tr>
<th>Cruise No.</th>
<th>Area</th>
<th>No. of hauls compared</th>
<th>Mean ship estimate</th>
<th>Mean observer estimate</th>
<th>Ratio</th>
<th>Inverse ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>142</td>
<td>B</td>
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<td>35.877</td>
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<td>1.001</td>
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<td>26.846</td>
<td>26.741</td>
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<td>.996</td>
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<td>181</td>
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<td>1.76</td>
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<td>57</td>
<td>26.210</td>
<td>40.657</td>
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<tr>
<td>205</td>
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<td>55</td>
<td>32.900</td>
<td>33.904</td>
<td>.97</td>
<td>1.03</td>
</tr>
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<td>51.660</td>
<td>67.462</td>
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<td>67.175</td>
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<td>.86</td>
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</tr>
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<td>25.500</td>
<td>37.156</td>
<td>.69</td>
<td>1.46</td>
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<td>234</td>
<td>B</td>
<td>34</td>
<td>33.304</td>
<td>34.549</td>
<td>.96</td>
<td>1.04</td>
</tr>
<tr>
<td>241</td>
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<td>36.500</td>
<td>36.493</td>
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<td>.99981</td>
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<td>11.787</td>
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<td>.96</td>
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<td>GOA</td>
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<td>27.791</td>
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<td>.96</td>
<td>1.04</td>
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<tr>
<td>Both</td>
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<td>56</td>
<td>24.178</td>
<td>24.921</td>
<td>.97</td>
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<td>25.364</td>
<td>26.385</td>
<td>.96</td>
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<td>53</td>
<td>27.000</td>
<td>30.037</td>
<td>.90</td>
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</table>

Overall (19 cruises) 1045 30.678 37.786 .81+ 1.23

Bering Sea 1002 30.802 38.168 .81 1.24
Gulf of Alaska 43 27.790 28.891 .96 1.04
Evaluation of Catch Rates on Japanese Surimi Trawlers
With and Without Observers in 1979
by
Robert French

Following the fishing season in the Bering Sea in 1979, it was noted that there was a wide discrepancy between the estimated catch (based on observer data) and foreign reported catch of Japanese surimi trawlers. It was known that there was a difference in daily catch rate of the two classes of surimi trawlers, but in 1979 observer sampling was conducted in proportion to the catch and effort of these two classes and, thus, the different fishing power of the two classes did not explain the difference between the reported and estimated catches. A further comparison of catch rates reported by vessels with observers versus those without has shown some interesting trends.

A week-by-week comparison of the mean reported catch per vessel day of pollock between vessels with and without observers shows that on the average, vessels without observers tend to report a lower catch per day of pollock then those vessels with observers (Table 1). The overall reported mean catch rate on vessels without observers was 80 mt/day whereas the mean catch rate on vessels with observers was 100 mt/day. The catch rate on vessels without observers was 20% less than those with observers.

The comparison of individual vessel catch rates prior to the boarding of an observer, the period an observer was on board, and after an observer's departure, shows a tendency for the catch rate to increase when an observer boards a vessel and then a decrease upon the observer's departure (Table 2).
Though these data do not prove or disprove any ideals we have had on the level of under-reporting, they do tend to reinforce the opinion that the presence of an observer has a positive effect on the accuracy of data reported by foreign vessels.
Table 1.--Comparison of reported mean catch per day (mt/day) for Japanese surimi trawlers with U.S. observers. Those without observers during 1979 (pollock only).

<table>
<thead>
<tr>
<th>Week Ending</th>
<th>Vessels w/Obs.</th>
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Annual Mean 100.3  80.0
Table 2.--Comparisons on Japanese surimi trawlers of the reported mean catch per day (mt/day) for the two weeks prior to boarding of an observer (obs.) vs. period with observer vs. two weeks after observer had disembarked (pollock only).

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Period</th>
<th>Mean catch rate prior to observer boarding (mt/day)</th>
<th>Percent change in catch rate/ (+ incr. - decr.)</th>
<th>Period with observer on ship (mt/day)</th>
<th>Percent change in catch rate/ (+ incr. - decr.)</th>
<th>Mean catch rate after obs left ship (mt/day)</th>
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<tr>
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<td>74.9</td>
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<tr>
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<td>Chikubu</td>
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<td>116.0</td>
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<th>Percent change in catch rate1/</th>
<th>Mean catch rate after left ship (mt/day)</th>
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<th>Percent change in catch rate2/</th>
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1/ The percent increase or decrease in reported mean daily catch rate from the two-week period prior to the boarding of the vessel by an observer to the period while an observer was on board.

2/ The percent increase or decrease in reported mean daily catch rate from the period an observer was on board to the two weeks after the observer's departure.

3/ One day before leaving.