Noise Characteristic of Japanese Fisheries Research Vessels

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Abstract: Noise is one of the important problems for hydroacoustic surveys of fisheries resources. High-frequency noise results in an overestimate of acoustic return. The noise measurements of five Japanese fisheries research vessels, ranging from 29.5m length to 93m length, were conducted to determine their noise characteristics. The echo-integrator output obtained only for noise was converted into the equivalent noise spectrum level that can be compared with noise signals received by other quantitative echo-sounding systems or from environmental sources. The dependence of noise upon the ship speed and the screw propeller’s setting was investigated for each vessel. The vessel’s performance for hydroacoustic survey is discussed from a viewpoint of noise level.

It is necessary to estimate and reduce the contribution of acoustic noise for precise and accurate hydroacoustic surveys of fisheries resources, because it may cause a large error in estimated fish density. Noise is classified into low-frequency noise (audible by fish) and high-frequency noise (affecting echo sounders). High-frequency noise usually results in an overestimate of acoustic return from fish and it may shorten the detectable range of the echo-sounding system. The average power of the high-frequency “self-noise” (1) of five Japanese fisheries research vessels was measured using an echo-integrator connected to a quantitative echo-sounding system (2). The dependence of noise on ship speed and propeller setting was investigated for each vessel.

METHODS

Noise measurements were conducted under calm weather and sea conditions. Research vessels sailed at a fixed speed on a preset course in an area with water depth greater than 200 m. The average volume back scattering strength obtained only for noise (noise SV) was measured with the echosounder transmitter disabled. Since TVG outputs of the noise are low at small ranges and increase with the range, we chose to start noise integration at depths greater than 100 m where noise contributions were well above our system’s minimum detectable SV. The threshold function was not used during noise measurements.

The noise SV was converted into the equivalent noise spectrum level (NP) which can be compared with noise received by other quantitative echo-sounding systems or with environmental noises. The conversion equation of noise SV to NP (2) is

\[ 2NP = SV - 20\log r - 2\alpha r - K - G \]  

where \( r \) is range, \( \alpha \) is an absorption attenuation coefficient, and \( K \) is a coefficient depend on the echo-sounding system characteristics and \( G \) is a system gain constant.

RESULTS

Table 1 shows principal characteristics of fisheries research vessels and their quantitative echo-sounding systems. The R/V “Kaiyo Maru”, the largest research vessel of the Fisheries Agency of Japan, has both electric-diesel and diesel propulsions. The electric-diesel propulsion is mainly used in hydroacoustic surveys.

Figure 1 shows results of the noise measurements of five research vessels. The Y-axis shows an equivalent noise spectrum level converted from noise SV, and the X-axis shows ship speed. All points are averaged over 5-10 minutes. The regression curves were derived for each vessel. Although the variation of the data is large, we
see the trend that increasing ship speed results in increasing noise.

TABLE 1. Principal characteristics of fisheries research vessels and quantitative echo-sounding systems.

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Year Built</th>
<th>Length overall (m)</th>
<th>Gross tonnage (tons)</th>
<th>Propulsion</th>
<th>Propeller¹</th>
<th>Echo-sounding system</th>
<th>Frequencies (kHz)</th>
<th>Type of transducer mounting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaiyo Maru</td>
<td>1991</td>
<td>93</td>
<td>2630</td>
<td>Diesel-electric</td>
<td>CPP</td>
<td>KAIJO &amp; JRC</td>
<td>38</td>
<td>Hull</td>
</tr>
<tr>
<td>Kaiyo Maru</td>
<td>1967</td>
<td>92</td>
<td>2644</td>
<td>Diesel-electric</td>
<td>FPP</td>
<td>KAIJO &amp; JRC</td>
<td>38</td>
<td>Towed body</td>
</tr>
<tr>
<td>Soyo Maru</td>
<td>1994</td>
<td>67.5</td>
<td>892</td>
<td>Diesel</td>
<td>CPP</td>
<td>KFC-1000</td>
<td>38, 70</td>
<td>Hull</td>
</tr>
<tr>
<td>Soyo Maru</td>
<td>1970</td>
<td>50.8</td>
<td>494</td>
<td>Diesel</td>
<td>CPP</td>
<td>KFC-200</td>
<td>25, 100</td>
<td>Hull</td>
</tr>
<tr>
<td>Taka Maru</td>
<td>1995</td>
<td>29.5</td>
<td>61</td>
<td>Diesel</td>
<td>CPP</td>
<td>KFC-500</td>
<td>38</td>
<td>Hull</td>
</tr>
</tbody>
</table>

¹CPP (Controllable Pitch Propeller), FPP (Fixed Pitch Propeller)

FIGURE 1. The equivalent noise spectrum level of five research vessels is plotted as a function of ship speed.

DISCUSSION

The R/V "Kaiyo Maru" and the R/V "Soyo Maru", which had been built in 1990's, were designed under explicit noise specifications(3). It is evident that their noise level is low. For example, the noise level of R/V "Kaiyo Maru" at 10 knots is about 20 dB lower than that of the former "Kaiyo Maru". The specifications for the newer vessels were determined by both engineering considerations and the requirements for hydroacoustic fisheries surveys. Noise measurements of smaller research vessels such as the R/V "Taka Maru" is an important part of our current research because of the need for acoustic specifications for smaller fisheries research vessels important in Japanese coastal areas.

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REFERENCES