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A STATISTICAL SAMPLING GUIDE TO INSPECT DOCKSIDE LANDINGS FOR ADHERENCE TO THE REGULATIONS IN THE FISHERY MANAGEMENT PLAN FOR SPINY LOBSTERS

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The Fishery Management Plan (FMP) for spiny lobster imposes restrictions on the size and reproductive condition of spiny lobster, Panulirus marginatus, which can be taken from the Northwestern Hawaiian Islands (NWHI). These regulations, as given in the Federal Register 47(126), are:

"§681.21. Size restrictions.

"(a) Whole lobsters. Only spiny lobsters with a carapace length of 7.7 cm or greater may be retained.

"(b) Lobster tails. If the carapace length cannot be determined, only lobsters with tails at least 5.0 cm wide may be retained, except for an allowance of up to 15 percent of the catch, by number, which may have tail widths between 4.5 and 4.9 cm.

"§681.22. Reproductive condition restrictions. A female spiny lobster of any size may not be retained if it is carrying eggs externally. Eggs may not be removed from female spiny lobsters."

As one activity to enforce these regulations, the National Marine Fisheries Service (NMFS), Southwest Region, will conduct dockside inspection of the catches from vessels landing lobsters taken in the NWHI. The purpose of this report is to present statistical sampling guidelines which will allow an enforcement agent to inspect a sample of a boat's catch and make a probabilistic statement about whether or not the catch conforms to, or is in violation of, the size and reproductive conditions imposed by the FMP. If the sample inspected indicates a high probability that the catch conforms to the regulations, then typically the catch would be landed without further inspection. If the sample inspected indicates a high probability that the catch includes a significant number of lobsters in violation of the regulations, then all the lobsters may be inspected for positive confirmation.

To develop the sampling guidelines, it is assumed that the sample of lobsters inspected is representative of the catch. From this assumption, it follows that the sampling theory can be developed based on a binomial distribution. It is further assumed that the proportions of the lobsters in the catch with an attribute about which an inference is being made does not exceed 0.25, and that the sample drawn does not exceed one-tenth of the catch. These assumptions insure that the Poisson distribution will be a very close approximation of the binomial distribution. The theory and tables for the sampling guidelines presented here are based on Burstein (1971).

Lobsters are presently landed either as live whole lobsters or are tailed at sea, and landed as frozen tails packaged in blocks. A separate sampling plan will be presented for each of these products.

Case 1. Inspection of live whole lobsters. The regulations in the FMP require that if the whole lobster is landed, its carapace length must equal or exceed 7.7 cm and that it does not carry eggs. The enforcement agent would use Table 1 to determine the size (n) of the random sample to be inspected, once values for parameters B and P have been selected. The value B determines the risk (probability) that a catch, which contains a proportion P or more of lobsters in violation of the regulation, is not detected. For example, if the agent wants to be sure that there is only a 1 in 20 chance that a catch with more than 1% of the lobsters in violation of the regulations on size and reproductive condition will escape detection, the value of B selected will be 1/20 = 0.05 and P = 0.01. From these values of B and P, Table 1 gives a sample size (n) of 299 lobsters to be inspected. If, in this random sample, a violation was found, then obviously the catch is in violation of the regulations. However, if in this sample of 299 lobsters there are no violations, then it can be stated that there is only 1 chance in 20 (B = 0.05) that the catch has more than 1% of the lobsters in violation of the regulations. If it is felt that stricter controls are required, for example, that there is only 1 chance in 100 (B = 0.01) that a catch with more than 0.5% (P = 0.005) of the lobsters in violation will not be detected, then it will be necessary to inspect a random sample of 918 lobsters.

Table 1.--Sample sizes (n) for selected values of P and B (from Burstein 1971).

n	P	B
118	0.025	0.05
299	0.01	0.05
598	0.005	0.05
146	0.025	0.025
367	0.01	0.025
736	0.005	0.025
180	0.025	0.01
458	0.01	0.01
918	0.005	0.01

Case 2. Inspection of frozen tails. The regulation requires that if frozen tails are landed, none carry eggs, none have widths of the first tail segment <4.5 cm, and no more than 15% of the catch have tail widths between <5.0 and ≥4.5 cm (the 15% tolerance). This case is more complicated than Case 1 due to the 15% tolerance condition. First, suppose we are just interested in sampling to insure that the 15% tolerance condition is not violated. An enforcement agent would select values of P_2, A, and B (Table 2) which then determine the sample size (n) to be inspected and the acceptance value C to test whether or not the 15% tolerance condition has been violated. The value B is the risk of not detecting a

violation in the 15% tolerance level when, in fact, the proportion of the catch with tail widths between <5.0 and ≥4.5 cm is $\geq P_2$. The parameter A is the probability that based on the sample inspected, it is erroneously concluded that the 15% tolerance is exceeded, when in fact, it is not. For example, based on values B = 0.01, A = 0.05, and P_2 = 0.25, a random sample of 208 tails would be measured; the acceptance value is 37 (Table 2). If fewer than 38 tail widths in the sample were <5.0 and ≥4.5 cm, then the catch would be accepted as conforming to the 15% tolerance condition and it can be concluded that there is only 1 chance in 100 (B = 0.01) that the proportion of the catch with tail width <5.0 and ≥4.5 cm would exceed 0.25 (P_2 = 0.25). If, however, more than 37 tails in the sample of 208 have widths <5.0 and ≥4.5 cm, then it can be concluded it is likely that the 15% tolerance level is exceeded in the catch since given the 15% tolerance, there is only 1 chance in 20 (A = 0.05) that more than 37 tail widths would be <5.0 and ≥4.5 cm, in a random sample of 208. In this latter case, all the tails would probably be measured for positive confirmation. Up to now, only the 15% tolerance level has been considered. When the sample size n determined from Table 2 is inspected, the agent will also check for any tails containing eggs and any tails with widths <4.5 cm.

Table 2.--Sample sizes (n) and acceptance values (C) for selected values of P_2, A, and B (from Burstein 1971).

n	C	P_2	A	B
208	37	0.25	0.05	0.01
170	31	0.25	0.05	0.025
143	27	0.25	0.05	0.05
781	130	0.20	0.05	0.01
659	111	0.20	0.05	0.05
527	90	0.20	0.05	0.05

If either of these attributes is found, the catch is in violation of the regulations. If, on the other hand, there are no tails with eggs, no tails have widths <4.5 cm, and the number of tail widths <5.0 and ≥4.5 cm does not exceed the acceptance level (C) in the sample, then the catch would be accepted as conforming to the regulations of the FMP. The probability of making a mistake and accepting this catch, when in fact, one or more of these conditions are violated is P_3 where:

$$P_3 = 1 - (1 - B_1)(1 - B_2)$$

where B_2 is the value of B from Table 2 and B_1 is the risk (B) from Table 1 for the value of n which is closest to, but does not exceed, the sample size inspected. For example, if a random sample of 208 lobster tails were inspected and fewer than 38 had widths <5.0 and ≥4.5 cm, and no tails were below 4.5 cm and none had eggs, then the catch would be accepted as conforming to the size and reproductive regulations of the FMP. The risk of an error, and the proportion of tails with widths <5.0 and $\geq$4.5 cm exceeds P_2 = 0.25 and the proportion of tails which either contain eggs and are <4.5 cm in the catch exceeds P = 0.025, can be determined by:

$$P_3 = 1 - (1 - 0.01)(1 - 0.01) = 0.02 \quad .$$

For this calculation of P_3, the value of B_2 is 0.01 from Table 2 based on n = 208, and the largest n in Table 1 not exceeding 208 is 180, which corresponds to P = 0.025 and B_1 = 0.01. Table 3 presents some values of P_3 for values of n from Table 2.

A practical consideration in sampling frozen tails is that a vessel may roughly sort the tails and package them in blocks at sea. In this situation, to take a random sample of size, n, from the vessel's catch, it will be necessary to select n packaged blocks at random and measure one tail selected at random from each block. The vessels landing frozen tails typically land about 6,000 pieces, so under our assumptions, the sample size inspected should not exceed one-tenth of the catch or about 600 pieces.

Table 3.--Values of P_3 computed for values of n, C, P_2, and B_2 from Table 2 and values of P and B_1 from Table 1.

n	C	P	B_1	P_2	B_2	P_3
208	37	0.025	0.01	0.25	0.01	0.02
170	31	0.025	0.025	0.25	0.025	0.05
143	27	0.025	0.05	0.25	0.05	0.10
781	130	0.005	0.025	0.20	0.01	0.03
659	111	0.005	0.05	0.20	0.05	0.10
527	90	0.01	0.01	0.20	0.05	0.06

LITERATURE CITED

Burstein, H.
1971. Attribute sampling, tables and explanations. McGraw-Hill, Inc., N.Y., 464 p.