INCIDENCE OF CULL LOBSTERS, *HOMARUS AMERICANUS*, IN COMMERCIAL AND RESEARCH CATCHES OFF THE MAINE COAST[1]

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ABSTRACT

Data obtained by port sampling the Maine commercial lobster catch (1968-74) and the natural lobster population near Boothbay Harbor, Maine, with research gear (1969-74) indicate that 6.5% of the commercially harvested lobsters have lost at least one claw while 21.0% of the lobsters (all sizes) in the natural population have missing and/or regenerating claws. An assessment of variations in cull frequencies associated with different seasons, fishing localities, and lobster size distributions suggests a direct relationship between fishing intensity and the incidence of culls. This information further supports Krouse and Thomas' recommendation that all lobster traps be equipped with an escape vent thus minimizing fishermen's needless handling of excessive numbers of sublegal-sized lobsters.

Over the years the occurrence of American lobster, *Homarus americanus*, with a missing and/or regenerating cheliped in the commercial landings has undoubtedly resulted in a significant financial loss to the fishing industry due to the culls' reduced weight and marketability (retail price of culls is less per pound). Scarratt (1973) reported that commercially caught lobsters from ports off Nova Scotia and Prince Edward Island had incidences of missing claws ranging from 5 to 19%. Although claw loss could not be attributed to a single factor, causes related to fishing such as rough handling by fishermen and movement of traps over the seabed were cited. Recognizing the importance of this situation, I have analyzed cull data provided by the Maine Department of Marine Resources Lobster Research Program's research catches (Krouse 1973) and sampling of the commercial catch (Thomas 1973). In this paper I attempt to assess the magnitude of the cull problem along the Maine coast, some of its causes, and a possible solution to diminish the number of culls.

METHODS

From June 1969 through December 1974, the occurrence of lobsters with missing and/or regenerating claw(s) in daily catches of research gear was noted. Carapace length in millimeters, weight in grams, and sex were recorded for each lobster. Wire lobster traps (2.54 × 2.54 cm mesh) were fished throughout the 6-yr period, whereas modified wooden traps with plastic escape vents of 3.81, 4.13, and 4.45 cm were not used until July 1972. Most experimental fishing was conducted in the vicinity of Capitol, Squirrel, and Damariscove islands in the Boothbay region of Maine (Figure 1).

Information pertaining to the frequency of culls in the Maine commercial catch from 1968 through 1974 was obtained from the probability sampling program described by Thomas (1973).

A length-weight relationship was calculated for 297 lobsters with a regenerating claw and for 225 lobsters with a missing claw collected near Boothbay Harbor, 1972-73. All lobster culls used in this determination had one normal sized claw. The regression of weight on carapace length for these two cull categories was fitted by the method of least squares using the logarithmic transformation $\log_{10} W = \log_{10} a + b \log_{10} L$.

RESULTS AND DISCUSSION

Seasonal and Size Variation in Cull Frequency

From the research catches I have calculated the percentage of culls by month and 5-mm size groups for 1969 through 1974 (Tables 1, 2). Fluctuations in the monthly percentages of culls seem to follow a seasonal pattern, i.e., the number of culls peaked

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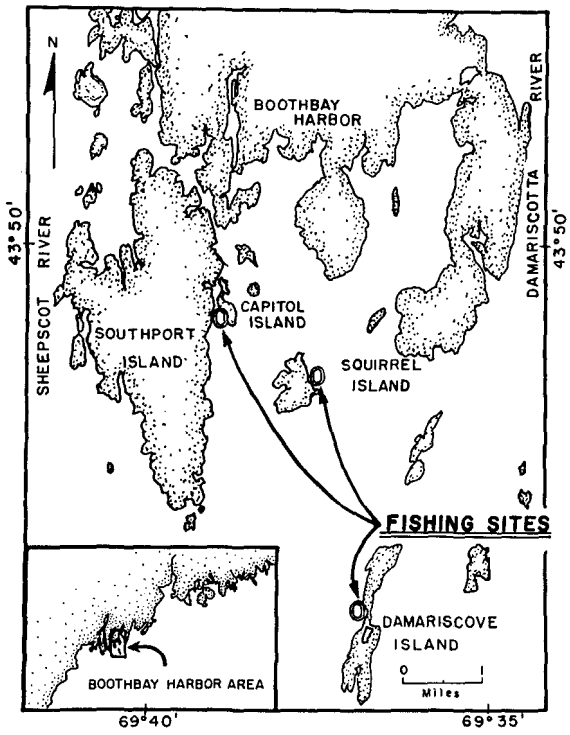

FIGURE 1.—Map showing the areas fished near Boothbay Harbor, Maine.

in the catch during winter-spring (26.9-31.3%), then subsided in July-August (18.1-19.4%), and increased in the fall (17.7-25.6%—variations in fall percentages may be due to sporadic shedding during this season). These seasonal changes might be related to the time of molting (July-September) associated with temporal fluctuations in fishing pressure. If we assume that a high percentage of the total number of culls are caused by fishing operations as suggested by earlier observations of fishermen's needless handling of excessive numbers of sublegal size lobsters (Krouse and Thomas 1975), then the decline in cull frequency during July and August (peak of shedding) may be explained, in part, by: 1) some culls losing this status after shedding and regenerating normal size claws, and 2) small lobsters (usually nonculls by virtue of their nonvulnerability to fishing gear) being recruited into the fishery at this time as a result of shedding. Even though the catch data of this study reveals that a high percentage of lobsters <45 mm carapace length were culls, most of these smaller culls probably acquired this condition while confined in our lobster traps.

TABLE 1.—Monthly incidence of lobster culls in research catches near Boothbay Harbor, Maine, 1969-74.

Month	Total no. examined	Culls (%)	Month	Total no. examined	Culls (%)
Jan.	16	31.3	Aug.	2,164	19.4
Feb.	26	26.9	Sept.	1,266	23.1
Mar.	34	29.4	Oct.	504	19.0
Apr.	83	26.5	Nov.	129	25.6
May	296	24.0	Dec.	62	17.7
June	805	24.0			
July	1,032	18.1	Total	6,417	21.0

TABLE 2.—Percentage of lobster culls by 5-mm size groups in research catches near Boothbay Harbor, Maine, 1969-74.

Carapace length (mm)	Total number caught	Culls (%)	Carapace length (mm)	Total number caught	Culls (%)
36- 40	19	26.3	76- 80	1,403	22.7
41- 45	77	33.8	81- 85	406	22.7
46- 50	160	21.9	86- 90	240	17.9
51- 55	333	19.5	91- 95	119	8.4
56- 60	542	23.2	96-100	20	10.0
61- 65	802	22.8	≥101	18	11.1
66- 70	1,046	19.3			
71- 75	1,232	19.2	Total	6,417	21.0

The frequency of culls by 5-mm increments (Table 2) indicated that culls are most prevalent at carapace lengths ≤45 mm and progressively less numerous at lengths ≥86 mm. The high incidence of culls for small lobsters can be attributed, at least in part, to these lobsters being particularly defenseless to claw loss inflicted by larger lobsters within the trap. On several occasions we have either caught small lobsters with recent claw losses in traps containing larger lobsters or actually witnessed larger lobsters destroying the claw of their diminutive opponent. To further substantiate this explanation of the two cull categories, i.e., regenerating and missing claws, the missing claw group predominated for lobsters ≤50 mm; however, for sizes ≥51 mm, lobsters with regenerating claws usually outnumbered those without claws (Table 3). This disparity was more pronounced for wood traps within the 81- to 85- and 86- to 90-mm groupings. Considering that legal-sized lobsters are handled only once and therefore are probably less prone to claw loss, then one would expect these larger lobsters to have a higher incidence of regenerating claws. Conversely, those sublegal-sized lobsters between 76 and 80 mm that are repeatedly discarded from the fishermen's catch have a preponderance of missing claws for catches with wire and wood traps.

The decline in the incidence of culls at the legal sizes (Maine minimum legal size is 81 mm carapace length) is manifested not only by the research

TABLE 3.—Percentage of lobster culls with missing claws by 5-mm size groups for research catches of wire and wooden traps.

Carapace length (mm)	Wire traps			Wood traps		
	Number of lobsters		Missing claw (%)	Number of lobsters		Missing claw (%)
	Regenerating claw	Missing claw		Regenerating claw	Missing claw	
36-40	2	3	60.0	—	—	—
41-45	2	15	88.2	—	—	—
46-50	7	15	68.2	—	—	—
51-55	15	15	50.0	—	—	—
56-60	50	34	40.5	—	—	—
61-65	62	45	42.1	—	—	—
66-70	65	51	44.0	2	8	80.0
71-75	74	55	42.6	16	15	48.4
76-80	57	74	56.5	59	66	52.8
81-85	14	17	54.8	30	17	36.2
86-90	4	2	33.3	20	10	33.3
≥91	1	1	50.0	5	5	50.0
Total	353	327	48.1	132	121	47.8

catches (Table 2) but also by the commercial catches for 1968-74 (Table 4). For both catches, more legal-sized culls occurred in the 81- to 85-mm size group while the percentage of culls gradually decreased for carapace lengths >85 mm. If, once again, it is assumed that fishing operations often cause culled lobsters and knowing that legal lobsters are handled only once and not repeatedly as may be the case for sublegal-sized lobsters, one would expect fewer culls amongst legal lobsters along with a gradual reduction in culls for sizes >85 mm. Since this study's data demonstrate this very pattern, my contention concerning the possible injurious effects of fishing activities on lobsters <81 mm is strengthened. Certainly there is a greater likelihood of a lobster becoming injured when as a result of fishing operations this lobster is: 1) crowded with other cannibalistic lobsters in a trap; 2) held captive in a trap which may undergo rigorous movement during a storm; 3) hauled boatside with appendages dangling between the trap's laths; and 4) removed from the trap while clinging to the trap, fishermen, or another lobster and eventually released for a descent to the ocean floor during which predation may occur.

TABLE 4.—Incidence of lobsters with missing claws by 5-mm size groups occurring in the commercial catch along the Maine coast (1968-74).

Carapace length (mm)	Total number caught	Culls (%)	Carapace length (mm)	Total number caught	Culls (%)
81- 85	5,322	8.1	106-110	219	3.7
86- 90	7,373	6.2	111-115	109	1.8
91- 95	5,580	5.2	116-120	41	4.9
96-100	1,208	3.7	≥121	6	0
101-105	368	4.3	Total	20,226	6.5

Effect of Fishing Intensity on Cull Frequency

The relationship of fishing intensity and its influence on cull incidence was investigated by calculating the frequencies of culls caught with wire and wood lobster traps (Table 5) at three different fishing sites near Boothbay Harbor (Figure 1). In addition, length-frequency histograms were constructed by 1-mm increments of the catches for each of the sampling sites (Figure 2). This analysis revealed that catches off Capitol Island, the most intensively fished area, contained more culls (23.3% for wire and 22.0% for wood traps) than either the catch of Damariscove (21.2%) or Squirrel islands (12.7% for wire and 17.9% for wood traps) which had the fewest culls. Although Damariscove and Squirrel islands appeared to have similar trap concentrations based on visual sightings of pot buoys, appreciably more culls were trapped at Damariscove. Possible reasons for this difference may be related to: 1) lobsters being maimed by excessive movement of traps over the substrate during storms off the more exposed seaward shoreline of Damariscove (waters fished at Squirrel were more sheltered); 2) Damariscove's greater abundance of small lobsters which are more vulnerable to injury [average size of lobsters in Damariscove catch was smaller than those of the other two areas (Figure 2), and the percentage of lobsters with missing claws was highest at Damariscove (Table 5)]; and 3) perhaps, an error in our rather subjective determination of nearly equal fishing intensities for both islands. Nevertheless, there does appear to be a positive

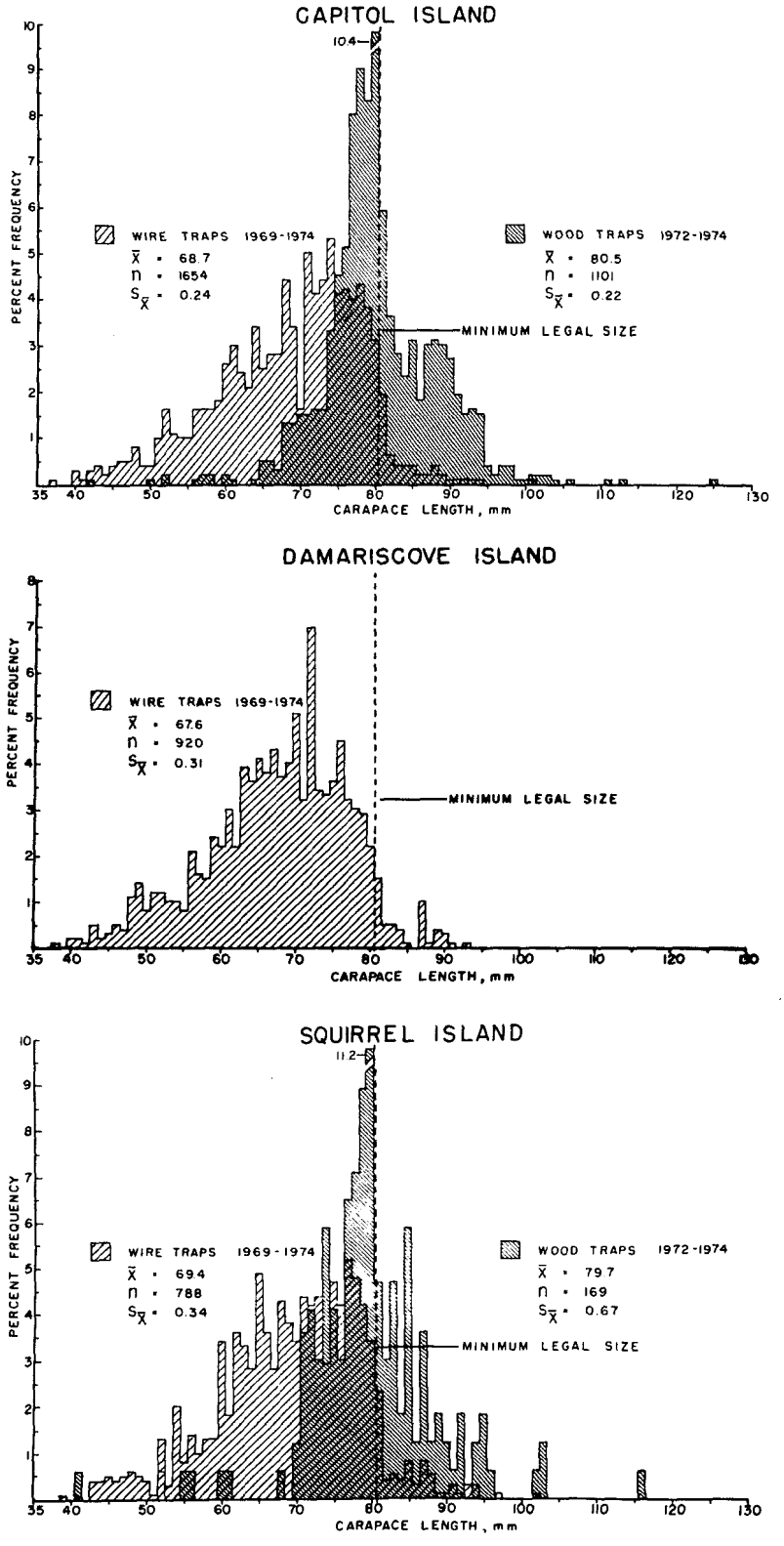

FIGURE 2.—Length-frequency histograms for the lobster catches with wire and wood traps for each of the three sampling sites near Boothbay Harbor, Maine.

TABLE 5—Comparison of the incidence of lobster culls in catches of wire and wood traps for various areas near Boothbay Harbor, Maine, 1969-74.

Gear and area	Total no. lobsters	Culls (%)	Regenerating claw (%)	Both claws regenerating (%)	Missing claw (%)	Both claws missing (%)	Regenerating and missing claws (%)
Wire traps:							
Capitol	1,627	23.3	10.6	1.8	9.1	1.1	0.7
Damariscove	920	21.2	8.4	1.0	10.0	1.0	0.5
Squirrel	787	12.7	6.9	0.5	5.1	0.1	0.1
Wood traps:							
Capitol	1,125	22.0	10.0	1.4	8.4	1.3	0.8
Squirrel	162	17.9	8.6	1.9	5.6	1.9	0

correlation between fishing intensity and incidence of culls; however, this does not preclude other factors such as predation, intraspecific competition, molting difficulties, and storm related damages.

Loss of Value of Catch Due to Culls

At the beginning of this paper I mentioned that culls have perennially detracted from the landed value of the lobster catch. To assess this situation, the regressions of weight for lobsters with missing and regenerating claws on carapace length for sublegal- and legal-sized lobsters were calculated. These curves were then compared to the length-weight relationship for noncull lobsters (Krouse 1973) (Figure 3). These comparisons reveal that noncull lobsters are about 14 to 20% heavier than those lobsters with regenerating and missing claws. Knowing these weight differentials and that about 6.5% of the lobsters in the commercial catch are missing at least one claw (Table 4) and that at least an equal percentage (6.5) of lobsters must have regenerating claws, the cull loss to the fishery can now be quantified. From the 1974 Maine Landings which reported a lobster catch of 16,457,666 pounds valued at $23,212,808, I estimated that the annual catch without any culls could have been increased by about 363,700 pounds (2.2%), adding $512,800 to the landed value. Unfortunately, there probably is no way to eliminate culls completely; however, proper size escape vents in all traps would be beneficial in effecting a marked reduction in the incidence of culls (Krouse and Thomas 1975). This reduction in culls would be the result of decidedly fewer numbers of sublegal-sized lobsters being handled by fishermen as indicated by the conspicuous disparity between the size composition of research catches with wire and vented wooden traps (Figure 2). Even if the cull loss could be lessened by only 25%, the industry would still realize an annual increase of about $128,000.

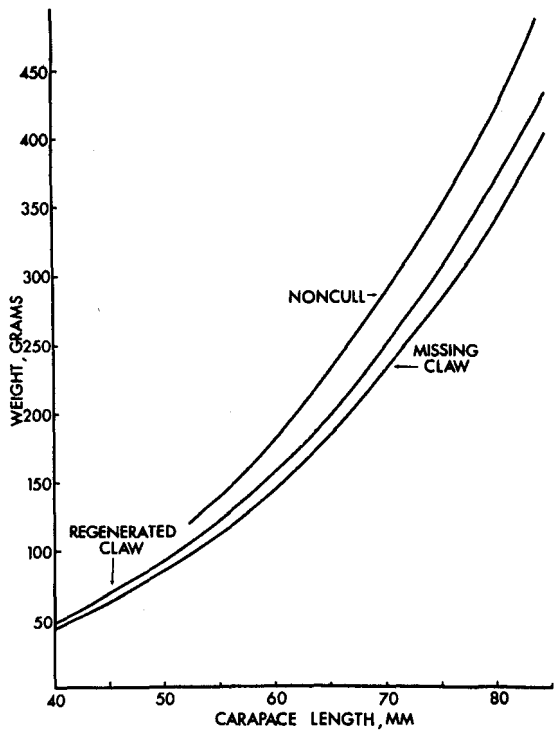

FIGURE 3.—Comparison of the calculated length-weight relationships for lobsters with regenerating, missing, and normal claws (noncull). The regression equations are: 1) regenerating claws: $\log_{10} W = -2.99 + 2.91 \log_{10} L$; 2) missing claws: $\log_{10} W = -3.03 + 2.92 \log_{10} L$; and 3) noncull: $\log_{10} W = -2.91 + 2.90 \log_{10} L$.

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LITERATURE CITED

KROUSE, J. S.
1973. Maturity, sex ratio, and size composition of the natural population of American lobster, *Homarus americanus*, along the Maine coast. Fish. Bull., U.S. 71:165-173.

KROUSE, J. S., AND J. C. THOMAS.
1975. Effects of trap selectivity and some population parameters on size composition of the American lobster, *Homarus americanus*, catch along the Maine coast. Fish. Bull., U.S. 73:862-871.

SCARRATT, D. J.
1973. Claw loss and other wounds in commercially caught lobsters *(Homarus americanus)*. J. Fish. Res. Board Can. 30:1370-1373.

THOMAS, J. C.
1973. An analysis of the commercial lobster *(Homarus americanus)* fishery along the coast of Maine, August 1966 through December 1970. U.S. Dep. Commer., NOAA Tech. Rep. NMFS SSRF-667, 57 p.