Effects of Harvest Techniques on Sublegal Spiny Lobsters and on Subsequent Fishery Yield

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RESUMEN

La pesca de la langosta espinosa (*Panulirus argus*) en los Cayos de la Florida, con 500,000 nasas, pretende mantener tanto como un millón de langostas juveniles sublegales ("cortas") como carnada. Los pescadores prefieren, por lo menos, 3-5 langostas "cortas" por nasa, pero corrientemente emplean más; se ha observado el empleo hasta de 15. Poco o ningun esfuerzo se ha hecho para rotar la carnada, eg. liberación de la langosta cuando se mantiene por largos períodos, excepto cuando las langosta obviamente parecen no ser saludables. Señaladamente mayores capturas se obtienen en nasas cebadas con tres cortas, comparadas con nasas cebadas con una corta o con cuero de res; no se observó diferencias de captura en los dos últimos casos. Los pescadores creen que las nasas sirven como cuevas (o refugios), y las langostas pueden liberarse cuando quieren, pero evidencias indican una alta tasa de retención en las nasas, con sólo una tasa de liberación de 5.6 - 8.4% semanalmente.

Las langostas sometidas a encierro en las nasas experimentan, consistentemente, pérdida en peso, probablemente por inanición, que conduce, en última instancia, a la muerte de algunas y reducción en la tasa de crecimiento en las sobrevivientes. La pérdida en peso aumenta con la densidad de langostas en una nasa. Las langostas sublegales frecuentemente sufren danos como resultado de la manipulación durante la pesquería. La reorientación en la energía de crecimiento resultante, por la regeneración de apéndices dañados, representa una disminución en la tasa de crecimiento de un 6.3% bajo condiciones óptimas, a un 40% cuando está expuesto a esfuerzos continuados. La práctica pesquera de mantener los cortos en cajas de pescado mientras son transportadas, dan por resultado una inmediata mortandad de langosta cuyo promedio es de 20.5%, y que puede alcanzar hasta un 40%. La mortandad está relacionada con el tiempo de exposicion y la densidad de langostas colocadas en las nasas. La tasa de mortandad total en las pesquerías de cortas y de las langostas legales es casi igual, lo que indica que la extracción de cortas de la población pesquera es semejante a la cuantía de langostas legales. La extracción ilegal puede ser de considerable importancia al explicar las pérdidas, pero una pesquería ilegal de cortas tendría que hacercarse, en magnitud, a la pesca legal para justificar las pérdidas. Daños, inanición, y mortandad en la práctica corriente de pesca para cebar con cortas tiene enormes efectos negativos en la cuantía de langostas que subsequentemente está disponibles para la pesca legal. La disminución o erradicación, de este sistema, conjuntamente con el cese de la pesca ilegal, produciría, aproximadamente, casi el doble de langostas de las que actualmente se encuentran disponibles para la pesca legal.

INTRODUCTION

Florida fishermen are allowed by law to place live, sublegal-sized [<76 mm carapace length (CL); short] spiny lobsters, *Panulirus argus* (Latreille, 1804), in traps as attractants (bait) for legal lobsters, and this method is preferred to use of formerly traditional baits such as fish heads or cowhide. The practice is employed by nearly all fishermen wherever shorts are available within the Florida Keys fishery. Permits may be obtained which allow transport of up to 200 shorts per vessel per day to bait traps. Three to five sublegal lobsters are usually placed in traps, but some fishermen use as many as 15 shorts per trap. Approximately 500,000 traps are deployed in the fishery (Gulf of Mexico Fishery Management Council, 1980). If no more than three shorts are used per trap, more than one million lobsters may be confined at any given time, and that sum increases as more shorts are added per trap. Little or no attempt is made to release shorts confined for extended periods except when lobsters appear unhealthy or when fishermen terminate trapping. The Florida Department of Natural Resources (FDNR) is investigating effects of the practice, and preliminary evidence indicates handling and confinement may profoundly affect numbers of lobsters subsequently available to the fishery.

EVIDENCE

Injury

Lobster injuries may substantially affect fishery yield. Appendages may be lost and other body parts may be damaged when lobsters are removed from traps, examined for legal size, placed in holding boxes and replaced in traps. Regeneration and repair require energy that otherwise would be used for natural growth, so growth is slowed, delaying entry into the legal fishery. Davis (1978) reported that 95% of lobsters he sampled in Biscayne Bay were immature juveniles; half of these had sustained injuries, many from fishing activity (including recreational harvest) that reduced growth by as much as 40%. Average growth rate of juvenile lobsters (40-85 mm CL) in Biscayne Bay was 21.3 mm CL per year, but growth of uninjured lobsters averaged 26.5 mm CL, whereas that of injured lobsters averaged only 16.1 mm CL annually. Average molt increment was 0.5 mm CL less and average intermolt period was 50% longer (15 vs 10 weeks) for injured lobsters. Degree of growth supression did not appear to be related to extent of injury; lobsters missing fewer than three appendages had growth rates virtually the same as others missing five or more appendages and/or other injuries (Davis and Dodrill, 1980). In the Everglades National Park area of Florida Bay, average annual growth of similar-sized juvenile lobsters was 40.0 mm CL, nearly twice that observed in Biscayne Bay (Davis and Dodrill, 1980). Average growth of injured lobsters in the National Park closely approximated growth of uninjured lobsters, lagging by only 6.3%. Davis and Dodrill concluded that better growth conditions and minimal disturbance reduced effects of injuries on lobster growth in the Park.

Lyons et al. (1981) concluded that most sublegal lobsters injured in the Florida Keys fishery did not return to the wild population. Old injury rates were greatest (18% legal; 26% sublegal) during the first month of the closed season and least (each 7.7%) during the last month of the closed season. Injury increase during the first month of the closed season was thought to result from release of bait lobsters at the end of the open season, and low injury rates during the final closed month probably approximated the rate of natural injury. After harvest commenced, rates of old injury gradually increased to 13% (legal) and 15% (sublegal) during the final harvest month, but incidence of injured shorts did not increase significantly beyond the incidence of injured legal lobsters. It was not known whether injured shorts entered the illegal harvest, died after release, or were unavailable for recapture because they were confined in traps as bait.

Escape

Miller and Sutherland (1978) studied behavior of short lobsters in standard slat traps monitored by remote underwater television. Their observations:

"Lobsters inside the Florida trap were inactive, fed, or made apparent efforts to escape. They successfully extracted bait from the bait containers. After feeding, the animals became inactive. This, in turn, was followed by more feeding or escape efforts. . . . Persistent climbing, probing, and efforts to squeeze between the laths were observed. . . . Lobsters escaped from the trap only when bait containers were suspended from the ceiling and lobsters were attempting to feed from them. The animals, in moving around on the bait container, crawled into, up, and out of the adjacent entrance funnel and escaped. . . . Some lobsters climbed out of the funnel onto the top of the trap, tried to reach the bait container from the roof, then re-entered the funnel and climbed back onto the bait container. Lobsters only escaped when trying to feed at the bait containers."

Many fishermen presently use no "dead" bait in traps, relying entirely upon short lobsters as attractants. Escape from traps lacking baited containers would expectedly be less likely than that witnessed by Miller and Sutherland.

Yang and Obert (1978) reported that 94.4% of 988 shorts used as bait in the Florida Keys remained in the same traps for 1-week soak periods. This value was significantly greater than that for tagged shorts released next to traps and subsequently recaptured in those traps, suggesting that lobsters able to leave traps freely would not be recaptured as frequently in the same trap and leading to the conclusion that many were not able to escape from traps. Davis and Dodrill (1980) found a consistent daily escape rate of 1.2% by shorts from unpulled traps monitored by divers for up to 14 days. Together, the studies indicate escape rates of 5.6-8.4% per week, or approximately 1% per day.

Fishermen contend that traps serve as dens which lobsters leave at night to forage, returning before daybreak. Because the previous experiments only examined traps during daylight hours, fishermen state that ability of lobsters to leave traps cannot be ascertained from those results. Field tests are underway wherein marked lobsters are placed in marked traps and examined daily and nightly by FDNR divers for 5 consecutive days to clarify the escape question. Preliminary results from four replicates of 10 traps containing four lobsters each indicate that, although activity in traps increases considerably at night, few lobsters escape and none return to the same traps from which they escaped. Average daily rate of escape thus far has been 1.8%.

Starvation

Marshall (1948) reported nine instances of molting with little or no increases in length or weight among spiny lobsters confined in "live cars." Weight loss was documented in six of the instances, even though lobsters were fed fish scraps once or twice a week.

In 1979, FDNR initiated tests to determine whether starvation resulted from confining lobsters in traps as bait over extended periods. Experimental lobsters were weighed, measured, tagged with spaghetti tags (Floy model 67-B), and sealed in unbaited traps by nailing slats over entrances. During experimental setup, lobsters were placed in holding boxes and dampened periodically with buckets of seawater for periods of 1.0-2.5 h. Traps were reset where lobsters were captured in the Florida Bay fishery area. Initially, 16 traps each containing five lobsters and 24 traps each containing three lobsters were deployed (40 total traps; 152 total lobsters). Two traps containing five lobsters and three traps containing three lobsters were terminated weekly and all measurements were retaken. Because considerable short-term mortality was encountered, additional traps were added to the experiment to obtain sufficient data on lobsters held at specified densities for required periods. Lobsters in those traps were marked by tail-clipping (cutting a small corner from a uropod or telson) and maintained in aerated seawater in large styrofoam chests for 0.5-3.5 h. Weight loss observations (Table 1) were based upon 143 lobsters.

Net weight loss was observed for both density configurations among each of the eight weekly test groups. Results indicated an initial high rate of weight loss during the first week, perhaps associated with initial capture trauma, then a reduction in loss rate through week 3, followed thereafter by generally greater losses probably attributable to starvation. Average weight loss was generally greater among lobsters confined at densities of five per trap compared to that of lobsters confined at densities of three per trap.

Mortality

Because high mortalities occurred after 2 weeks of the initial starvation experiment, further setups were curtailed. Mortality after 3 weeks averaged 50% but was almost 69% among lobsters placed five to a trap (Table 2). At this point, it was necessary to overcome mortality to allow studies of weight loss, so the process was reinitiated with previously mentioned changes. Losses in the second starvation experiment were considerably less. Death rates decreased after 2 weeks among lobsters at densities of three per trap but continued to be high for several weeks among lobsters at densities of five per trap.

Studies by National Park Service biologists revealed additional evidence of trap-related mortality to *Panulirus argus* in south Florida. In tests conducted during 1978-79, they found that mortality among both tagged and tail-punched lobsters placed in traps increased markedly between 7 and 14 days, totalling 34% after two weeks (J.W. Dodrill and G.E. Davis, personal communications).

Research by FDNR was consequently redirected to address causes of mortality. Four areas of concern were identified: (1) brief handling and subsequent shock; (2) desiccation (drying during exposure); (3) temperature during exposure; and (4) density of lobsters in traps. Because changes in handling and exposure methods had

Table 1. Average weight loss (grams) per week among lobsters confined in unbaited traps

	Week							
Density	1	2	3	4	5	6	7	8
3*	—	—	—	—	—	—	- 5.8	- 9.2
3	-4.3	-1.5	-1.9	-3.9	-1.6	-6.8	-10.3	- 5.3
5	-5.2	-3.0	-2.3	-7.4	-6.5	-5.8	- 2.8	-10.6

*Tagged lobsters. Because of high initial mortality, experiment was restarted; subsequent lobsters were kept in holding tank aboard vessel and marked by tail-clipping.

Table 2. Weekly mortality of spiny lobsters during starvation experiments.

	Week 1	2	3	4	5	6	7	8	Total Dead
Tagged; Holding box.									
Density 3 (N=27)									
Dead	3	4	0	0	2	1	1	1	12
% cumulative mortality	11.1	25.9	-	-	33.3	37.0	40.7	44.4	44.4%
Density 5 (N=35)									
Dead	11	9	4	0	0	0	0	0	24
% cumulative mortality	31.4	57.1	68.6	-	-	-	-	-	68.6%
Both (N=62)									
Dead	14	13	4	0	2	1	1	1	36
% cumulative mortality	22.3	43.5	50.0	-	53.2	54.8	56.4	58.1	58.1%
Tail-clipped; Aerated tank.									
Density 3 (N=96)									
Dead	9	7	1	0	0	0	1	1	19
% cumulative mortality	9.7	16.7	17.7	-	-	-	18.8	19.8	19.8%
Density 5 (N=135)									
Dead	10	11	5	8	5	2	1	0	42
% cumulative mortality	7.5	15.7	19.4	25.2	28.9	30.4	31.1	-	31.1%
Both (N=231)									
Dead	19	18	6	8	5	2	2	1	61
% cumulative mortality	8.4	16.1	18.7	22.1	24.2	25.1	26.0	26.4	26.4%

improved survival during the second starvation experiment, these were selected for testing. Preliminary results of these tests, as well as some information regarding density, temperature and predation, are presented here.

Handling. Lobsters were obtained as in the starvation experiment. The experiment was divided into five subgroups, each employing five traps containing three lobsters:

(A) Control: traps containing three lobsters when pulled were immediately sealed and returned to the water; lobsters were not handled.

(B) Holding box: lobsters were removed from original traps, placed in holding boxes for less than 15 min, then placed in other traps which were sealed and returned to the water.

(C) Tail-clipping: treatment as in B (above); additionally, a corner was cut from the uropod or telson of each lobster.
(D) Tagging: treatment as in B (above); additionally, each lobster was tagged with a spaghetti tag.
(E) Measuring: treatment as in B (above); additionally, tails were clipped, and each lobster was measured for carapace length, total length and weight.

All lobsters were removed from the water for periods less than 15 min. Experimental traps were reset in the Florida Bay fishery area and pulled weekly for 4 weeks thereafter. Numbers of remaining lobsters in each trap were tabulated for each weekly pull. Five replicates of each test have been attempted, and four have been completed successfully.

Occasional vandalism occurred throughout the program, involving removal of trap lids, tearing out slats or cutting buoy lines. When such tampering was evident, those traps were removed from analyses and numbers reduced accordingly. The entire fifth replicate conducted during late July-early August was so severely vandalized that no useful results were obtained.

Results of four replicate tests confirmed that tagging was an important cause of mortality (Table 3). The 30.7% average tagging mortality witnessed among 53 tested lobsters was similar to the 31.7% mortality difference (58.1%-26.4%; Table 2) between tagged and tail-clipped lobsters witnessed in the starvation experiment. Results for tests of other handling techniques differed little from those of the control group except for test group E (tail-clip plus all measurements). Apparent higher mortality in this group resulted because all six lobsters were missing from two traps at the end of the first week of one replicate. Although both traps were intact, the next trap in that replicate was definitely vandalized; the buoy line was cut and three slats were torn out. If lost lobsters from those two traps resulted from vandalism, cumulative mortality in test E at the end of 4 weeks would have been only 5.9%.

Exposure. The exposure experiment was divided into four subgroups, each employing five traps containing three lobsters obtained as in the starvation experiment. The control for this experiment was the same set used to evaluate effects of handling (Table 3). Captured lobsters were placed in holding boxes at densities of 15 lobsters per box; boxes were placed in open shade aboard the vessel, and lobsters were dampened with buckets of seawater at 30 min intervals. Lobsters were placed back in traps after exposure intervals of 0.5, 1, 2 and 4 h; entrances were then sealed and traps were returned to the water. Traps were pulled weekly thereafter for four weeks as in the handling experiment. Some vandalism also occurred during these tests, requiring numerical adjustments during analyses. Five replicates were initiated, but, as in the handling experiment, the July-August replicate was totally destroyed by vandalism.

Desiccation due to exposure was clearly an important contributor to mortality. Only 3.3% mortality was experienced by the control group (Table 3), whereas average mortality of lobsters in exposure tests was 21.0% (Table 4). Average mortality of lobsters exposed 0.5 h was approximately half the average values of lobsters exposed for longer periods. Deaths among lobsters exposed 2 and 4 h occurred principally during the first week, whereas lobsters exposed 1 h survived longer, but cumulative death rates were similar for exposures of 1-4 h by the end of the fourth week.

Table 3. Average spiny lobster mortality due to various handling techniques, combined results of four replicate tests (7 January - 16 June 1980).

Test*	N		Week 1	2	3	4	Total
A	60	Dead:	0	1	1	0	2
		% cumulative mortality:	0	1.7	3.3	3.3	3.3%
B	60	Dead:	0	2	1	2	5
		% cumulative mortality:	0†	3.5	5.3	8.8	8.8%
C	60	Dead:	0	0	0	0	0
		% cumulative mortality:	0‡	0	0	0	0%
D	60	Dead:	6	4	5	1	16
		% cumulative mortality:	10.0	18.9§	28.3	30.7‖	30.7%
E	60	Dead:	7	0	0	2	9
		% cumulative mortality:	12.3†	12.3	12.3	15.0	15.0%

*A. Control: trap containing 3 lobsters sealed; no handling. B. Fish box only: lobsters held in fish box less than 15 min., replaced in traps. C. +Tail-clip: like B, but small corner cut from tailfan. D. +Tagged: like B, but tagged. E. +Tail-clip and all measurements: like C, but measured (handled) for carapace length, tail length, total length and weight.

†One trap, 3 lobsters lost; subsequent N = 57; cumulative mortality adjusted accordingly.

‡Two traps, 6 lobsters lost; subsequent N = 54; cumulative mortality adjusted accordingly.

§Three traps, 7 lobsters lost; subsequent N = 53; cumulative mortality adjusted accordingly.

‖One trap, 1 lobster lost; subsequent N = 52; cumulative mortality adjusted accordingly.

Lobsters in the first starvation test were exposed in holding boxes for 1-2.5 h, so average mortality for 1-4 h exposure (22.2-26.3%; $\bar{x}$ = 24.1%; 162 lobsters) during the exposure experiment may account for most deaths not ascribable to tagging during the first starvation test. The fact that average cumulative mortality was 26.4% during the second starvation test, when lobsters were not tagged, suggests that maintaining lobsters in aerated tanks did little to reduce mortality.

Fishermen contend that they do not dampen lobsters in holding boxes because dampening increases mortality (Gulf of Mexico Fishery Management Council, 1980). However, FDNR observers aboard commercial lobster vessels found that many fishermen do dampen shorts periodically, and Florida law requires that shorts transported aboard vessels to bait traps be periodically dampened.

The Western Australian Department of Fisheries and Wildlife (1980) recently studied effects of exposure to juvenile *Panulirus cygnus* George, 1962. Shorts are not customarily used as bait in Western Australia, but many fishermen initially place all trapped lobsters in holding boxes, sorting the catch later and then returning juveniles to the water. Effects of this practice were tested by exposing lobsters in holding boxes for 0.5, 1, 2 and 3 h, then tagging and releasing them and evaluating subsequent returns of tagged lobsters; control lobsters were captured, tagged and

Table 4. Average mortality of spiny lobsters maintained in holding boxes for periods of 0.5, 1, 2 and 4 h, combined results of four replicate tests (7 January-6 October 1980).

Exposure (hrs)*	N		Week 1	2	3	4	Total
0.5	60	Dead:	5	2	0	0	7
		% cumulative mortality:	8.3	11.7	11.7	12.3†	12.3%
1	60	Dead:	4	2	3	3	12
		% cumulative mortality:	7.8§	11.8	17.6	23.5	23.5%
2	60	Dead:	8	1	0	3	12
		% cumulative mortality:	14.8‡	16.7	16.7	22.2	22.2%
4	60	Dead:	9	3	3	0	15
		% cumulative mortality:	15.0	20.0	25.0	26.3†	26.3%
Combined	240	Dead:	26	8	6	6	46
		% cumulative mortality:	11.6	15.1	17.8	21.0	21.0%

*Controls as in handling experiment (Table 3).

†One trap, 3 lobsters lost; subsequent N = 57; cumulative mortality adjusted accordingly.

‡Two traps, 6 lobsters lost; subsequent N = 54; cumulative mortality adjusted accordingly.

§Three traps, 9 lobsters lost; subsequent N = 51; cumulative mortality adjusted accordingly.

returned to the water immediately. Returns of lobsters exposed 0.5 h were only about 30% of those from the control group, and lobsters exposed 1, 2 and 3 h were recaptured at rates only about 7% that of controls. These values, suggesting 70 and 93% mortalities of exposed lobsters, represent even more dramatic losses than those witnessed in FDNR experiments.

Density. Deaths related to density of lobsters in traps were evident in both starvation tests. Traps containing five lobsters produced 54% greater mortality among tagged lobsters and 57% greater mortality among tail-clipped lobsters than did traps containing three lobsters similarly marked.

Temperature. Effects of air or water temperature were not evident during exposure tests. Temperatures during experimental setups in January and February were considerably cooler (air: 15.2-21.0°C; water: 17.0-17.5°C) than those during May and September setups (air: 27.6-33.5°C; water: 29.3-29.5°C), yet total average mortalities for the two periods were similar (20.5% vs 21.5%), and average mortalities of lobsters exposed 1-4 h were identical (24.1%).

Predation. Octopi are well known predators of crustaceans, including spiny lobsters. Incidences of octopus-induced mortality were difficult to assess during FDNR tests. Deaths in traps were variously indicated by freshly dead lobsters, remnants of exoskeletons, or complete absence of an animal. Octopi were occasionally observed clinging to traps. In one instance, an octopus was found in a trap with three healthy lobsters, and in another, an octopus was found in a trap with a freshly dead lobster. That death was probably caused by the octopus. Although not related to handling or exposure, octopus-induced mortalities may be an additional adverse effect created by baiting traps with live lobsters. Animals so confined have far less probability of escaping predators than would others occupying natural dens, and such confinement may expose them to much greater predation rates.

Effectiveness as Bait

Yang and Obert (1978) showed that both total catch per trap and legal catch per trap improved significantly when one or more shorts were used as bait. However, their data were not analyzed to determine differences in effectiveness between traps containing one short versus traps containing more lobsters.

During 1978-79, an experiment testing efficacy of traps baited with cowhide versus traps baited with cowhide and tagged shorts was conducted to obtain values for comparison with commercial catch rates, since traps were not baited with shorts during the regular FDNR program (Lyons et al., 1981) because of statistical complications. Mean experimental catch rates were: 1.15 lobsters per week from traps baited only with cowhide; 1.90 lobsters per week from traps baited with cowhide and one short; and 4.2 lobsters per week from traps baited with cowhide and three shorts. All means were significantly different, indicating that one new lobster would be caught for each short used as bait.

IMPACT ON THE FISHERY

Catch per unit effort in the Keys fishery has declined to approximately one-third that of 2 decades ago. A large portion of the population is harvested prior to attainment of sexual maturity, and virtually no females survive to sizes at which optimal spawning contributions are realized (Lyons et al., 1981). Areas previously serving as nursery sanctuaries are now subject to intensive fishery pressures due to increased demand, accelerated competition for existing stocks, and a minimum legal size that does not protect juveniles. The mortality rate of sublegal lobsters is essentially the same as that of the legally harvestable population (Yang and Obert, 1978; Lyons et al., 1981), indicating that combined effects of illegal harvest and damage to sublegal stocks by baiting practices severely reduce potential fishery yield.

Some factors contributing to problems in the Florida Keys fishery are socioeconomic. Over-capitalization in the lobster industry resulted in an inflationary spiral of trap usage in which some fishermen now deploy as many as 6,000 traps pulled at a minimum of 2-week intervals. The resultant 500,000 traps in the fishery in turn created an increased demand for conventional baits (fish heads, cowhide). As a consequence, bait availability decreased and prices increased such that fishermen turned to alternative baiting techniques. At this point, the socioeconomic problem became a biological problem because the solution to the bait problem was to substitute live, sublegal-sized lobsters for more expensive baits.

A statistical model of the Florida spiny lobster fishery has yielded the conclusion that potential landings in the Florida Keys should be 103% greater than the present recorded catch (Austin et al., 1980). Recent studies have produced estimates that recreational harvest is slightly less than 10% of the commercial catch (Davis and Dodrill, 1980; FDNR, unpublished), amounting to slightly more than 230 metric tons annually (Zuboy, 1980), so that cannot account for the difference. Fishermen contend that quantities of legally landed but unreported lobsters may amount to 10-30% of the commercial catch (Gulf of Mexico Fishery Management Council, 1980), but no data exist to verify these values.

The evidence indicates enormous losses (63-83%, discounting recreational and unreported legal harvest) to the legal fishery attributable either to illegal harvest of shorts or to fishery-induced mortality. If both practices are abated, data indicate that approximately twice the number of lobsters should be available for legal harvest. The extent of the illegal fishery is unknown, but its existence is verified by periodic arrests. Its magnitude has been estimated by fishermen to approach 20-50% of legal harvest (Beardsley et al., 1975; Warner et al., 1977; Gulf of Mexico Fishery Management Council, 1980), but again there are no data. On the other hand, considerable evidence indicates that fishery techniques are heavily impacting existing stocks of sublegal lobsters, delaying or prohibiting their entry into the legal fishery.

To increase legal catches, injury and death to juvenile stocks must be curtailed. The most effective protection requires that sublegal lobsters not be handled. However, fishermen claim that to prohibit use of shorts as bait would create severe economic hardship (Gulf of Mexico Fishery Management Council, 1980). The solution demands development of an effective, inexpensive bait to replace shorts. When such bait becomes available, it will be necessary to require escape gaps in all traps to minimize contact with sublegal lobsters. Only then will Florida begin to realize the potential of its fishery population.

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