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A COMPARISON OF CATCH RATE BETWEEN A TRADITIONAL, BASKET-STYLE HOOP NET AND A RIGID, CONICAL-STYLE HOOP NET USED IN THE CALIFORNIA RECREATIONAL LOBSTER FISHERY

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ABSTRACT

We compared the relative catch efficiencies of two types of hoop net commonly used in the recreational California Spiny Lobster fishery. One net type is basket shaped but lies flat on the bottom during deployment and represents the traditional hoop net design. The other type is a recent development that maintains its rigid, conical shape during both deployment and recovery. Our study took place at Zuniga Jetty, a submerged rock jetty in San Diego, over 7 nights in August/September, 2008. A total of 96 nets (48 of each type) were deployed. Catches of the two net types differed with the rigid hoop nets catching 57% more lobster total than the traditional hoop nets (Rigid:Traditional = 259:165 lobsters caught). In addition to lobster, deployment of both styles of nets resulted in bycatch of various finfish and invertebrate species. This increased catch efficiency of a net type that is growing in popularity, coupled with increases in access to lobsters, interest in lobster fishing, and marketing of hoop nets, has the potential of enlarging recreational catch.

INTRODUCTION

The California spiny lobster, *Panulirus interruptus*, is targeted by both commercial and recreational fisheries in southern California. Both fisheries are managed by a minimum carapace size limit, season restrictions, and license and gear restrictions. Commercial take is exclusively through the use of traps; and the fishery is restricted access. Recreational regulations authorize a bag limit of seven lobsters to be captured by hand, usually while skin or scuba diving, or by use of baited hoop nets. Anglers are allowed to use up to 5 nets per person with no more than 10 nets per vessel. However, the law does not define what constitutes a hoop net.

Traditionally, lobster anglers have used a hoop net that consists of two metal rings of different sizes attached to each other with mesh netting (Fig 1A). While deployed, the rings and netting lay flat on the bottom but assume a funnel-shaped basket during retrieval. The catch is hauled to the surface inside the open top basket. Some skill is thought to be required in retrieving this net. The net initially must be pulled in such a manner that it forms a complete basket before the catch escapes from the net. Once off the bottom, a vertical and steady pull to the surface is recommended to keep the

catch pinned to the mesh, thus preventing the catch from escaping out the top.

In recent years, a modified version of the traditional hoop net has become popular

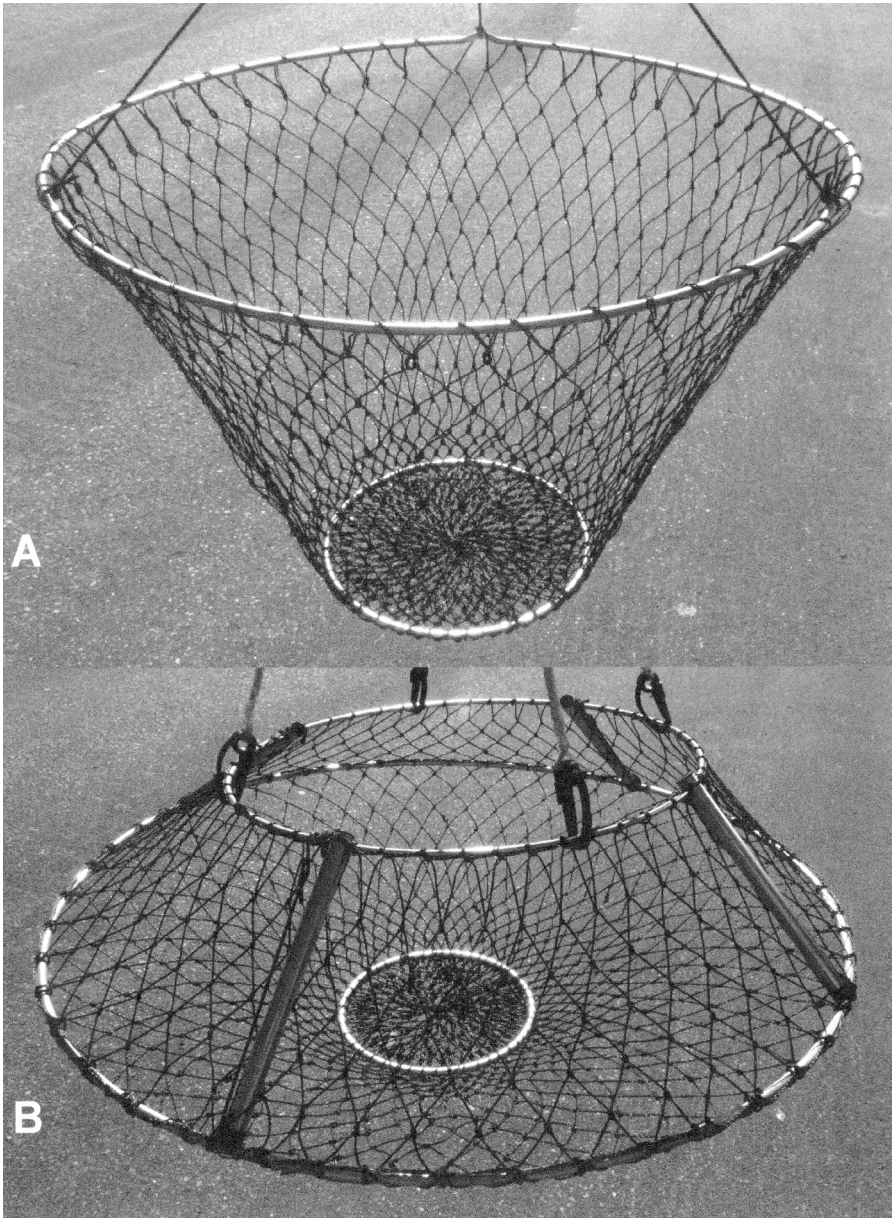

Figure 1. A) Fully expanded traditional-style hoop net. This style lies flat on the bottom during deployment and takes the pictured, basket shape when pulled. Bait is placed in webbing inside the small ring. B) Rigid-style hoop net shown as deployed. This style of net maintains the same shape when pulled.

in the recreational fishery. This design uses rigid supports to prop up an additional metal ring above the hoop net (Fig 1B). This style of net does not lie flat on the bottom during deployment and the mesh netting between the suspended ring and hoop net proper forms a collar around the top of the net. The suspended ring is also generally smaller in diameter than the hoop net's larger base ring, further decreasing the chance of escape during retrieval. Consequently, the rigid nets are considered to be more forgiving of off-vertical retrievals.

California Department of Fish and Game (CDFG) enforcement and resource management personnel are concerned that the new, rigid hoop nets may be far more efficient at capturing lobster than the traditional design. This, coupled with anecdotal evidence that suggests that the hoop-netting effort has increased in recent years, prompted this study to quantify the relative catchability of the two hoop net designs.

METHODS AND MATERIAL

Hoop Nets

We used traditional-style Promar[1] Jumbo Lobster/Crab Hoop Nets (NE-102J) and rigid-style Promar Eclipse Hoop Nets (NE-108) for this study. The traditional-style Promar net is composed of two rings: a 91.4 cm diameter upper ring and 35.6 cm diameter lower/bait pocket ring (Fig. 1A). Although the net is collapsed on the bottom when set, it expands to a 50.8 cm deep basket during the pull. The rigid nets have a 91.4 cm diameter base ring, a 25.4 cm diameter bait pocket ring, and a third, 50.8 cm diameter top ring suspended 25.4 cm above the base ring by rigid supports (Fig. 1B). This style of net maintains its conical shape in both fishing and retrieval. Both nets are covered by black, knotted polyethylene netting with mesh size varying larger to smaller from the top to bottom of the net. All nets were rigged identically using Promar ropes, floats, and harnesses. The harnesses were attached to the upper and base rings of the traditional and rigid style nets, respectively.

Study Site

Zuniga Jetty, just outside San Diego Bay, was chosen for our study site. The jetty is convenient to marinas and launch facilities, and is a popular hoop netting location during lobster season. Anecdotal evidence from fishing reports found on various internet websites, suggested a high, uniform density of lobster existed in the study area, a necessary condition when comparing the catch rate of the two net styles. The jetty is a submerged rock jetty extending approximately 1800 m southward from Zuniga Point on the Naval Air Station North Island, San Diego, CA. It forms the east side of the entrance channel to San Diego Bay (Fig. 2), and is marked by five flashing, navigational lights designated 'V' (inshore) through 'Z' (offshore) spaced

[1]Reference in this paper to any specific commercial product or brand name does not constitute endorsement or recommendation by the California Department of Fish and Game, or its employees.

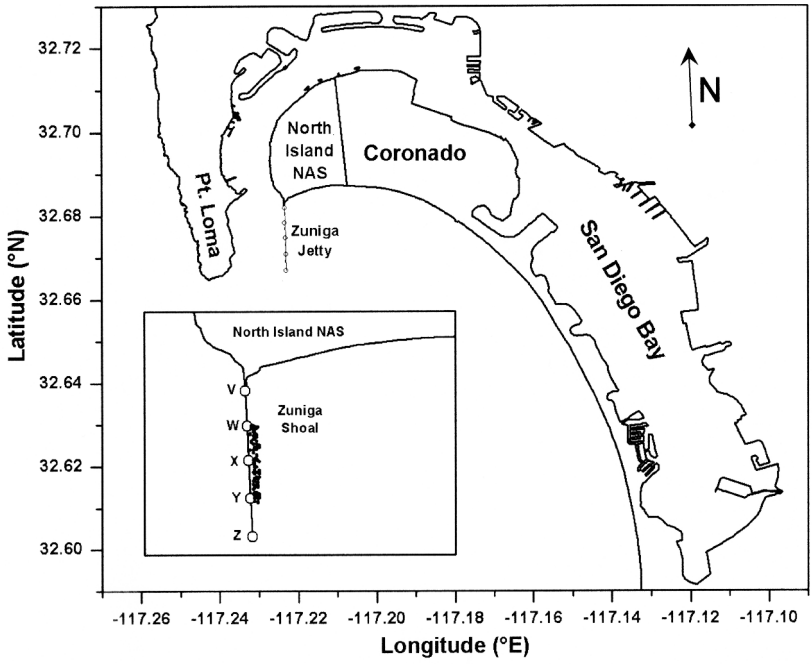

Figure 2. Location of Zuniga Jetty relative to San Diego Bay. Inset: Locations of flashing navigational lights 'V' through 'Z' (open circles) along Zuniga Jetty. The study site was restricted to the area between 'W' and 'Y' on the side of the jetty opposite the entrance channel into San Diego Bay. The location of each hoop net set is designated by a black dot in the inset.

approximately 400 m apart. "Zuniga Shoal", a sand bar with extensive sea grass beds, extends eastward on the side opposite the entrance channel. Water depths along the shoal side of the jetty range from intertidal to about 8 m at the offshore end. While the top of the jetty can be exposed, particularly at low tide, the profile of the jetty on the shoal side is fairly vertical; it is possible to be within a meter or two of the structure while still showing a flat bottom under the boat.

Sampling Design

We deployed our nets on 7 separate nights in August and September, 2007, just prior to the 2007/2008 lobster season, and during at least one of three time intervals on any given night: 2020LT (local time)-2130LT, 2130LT-2300LT, and 2300LT-0030LT. The first interval started about a half hour after sunset, and weather and sea conditions dictated whether subsequent intervals were fished.

All nets were set on the shoal side of Zuniga Jetty between lights 'W' and 'Y' (Fig. 2). We divided the approximately 800 m (0.5 mi) section into eight zones, with Zone 1 starting at light 'W'. Zones were measured linearly along the length of the jetty and nets were deployed as close to the jetty as conditions allowed without

setting on the structure itself. Set depths ranged from approximately 3.0 m at 'W' to 6.5 m at 'Y'.

A single set was defined as the deployment of eight hoop nets. One hoop net was deployed per zone, alternating between rigid and traditional nets. Over the course of the study, the net styles were deployed an equal number of times in each zone. The initial sample design called for an equal number of sets for all three time intervals. However, starting on day 4, we decided to continue the sampling only during the first time interval. This was due to logistical concerns and early results that suggested we were well in excess of the 25% difference in catch dictated by the power analysis (see statistical methods description below). As a result, we had fewer samples during each of the final two time intervals than during the first. Zones were fished in order, beginning at Zone 1 and continuing to Zone 8. No attempt was made to relocate previous start locations in Zone 1, and set points in subsequent zones were determined by speed and cruise time along the jetty. The additional influences of wind and currents guaranteed a haphazard set location within each zone. The nets were set at 5-minute intervals and, immediately after setting the last net, we returned to the first zone and began retrieving. Although we attempted to pull the nets at 5-minute intervals, the time needed to process a zone's catch occasionally increased the soak times in subsequent zones. A 40-minute soak time was the target. All nets were baited with two whole mackerel, the condition and size of which were consistent among all nets for any given set series. Additionally, the mackerel were sliced open to help create a scent trail.

All sets and pulls were made by the same person over the course of the study to ensure a consistent pulling technique. We recorded the time, GPS location, and bottom depth for each net upon deployment and recorded the time, total number and sex of each lobster captured upon recovery. We also noted the amount of bait left in the net. Life history parameters for each lobster also were measured (e.g., carapace length). These data will be discussed in a future note.

Statistical Methods

A simple catch-per-unit-effort (CPUE) was calculated by dividing the total catch by the total number of nets deployed over the study period. CPUE was determined separately for traditional and rigid hoop nets. Before running statistical tests, counts were normalized to 40-minute soaks (this normalization assumes a uniform arrival of lobsters over this period). A Chi-Squared Goodness of Fit was used to compare the total catch of rigid and traditional nets against an expected 50/50 split. The minimum number of net deployments needed for this study (32) was determined by power analysis, given a 25% or greater difference in catch at the 95% significance level ($\alpha = 0.05$) with a power ($1 - \beta$) of 0.80.

The overall distribution of lobster along the jetty is essentially unknown as is the existence and timing of any movements between the jetty and neighboring eelgrass beds on Zuniga Shoal. In order to measure whether a difference in abundance based on time interval of set , location along, or location from the jetty existed in our data,

we tested for relationships between catch and time/location along the jetty using simple correlations evaluated at the 95% significance level. The specific relationships evaluated were between the number of lobsters caught and 1) set time interval, 2) distance from jetty, and 3) set depth (roughly equivalent to distance along jetty). Because the study included an uneven number of sets by time interval and an uneven representation by zone of hoop net types at the two later time intervals, we also used the result of these correlations to justify mixing all sample data for the final analyses.

RESULTS

Ninety-six hoop nets, 48 rigid and 48 traditional, were deployed in 12 sets (Fig. 3) and 424 lobsters total were caught with actual soak times averaging 46 ± 7 minutes. Nineteen of the nets no longer held bait when recovered, although only one

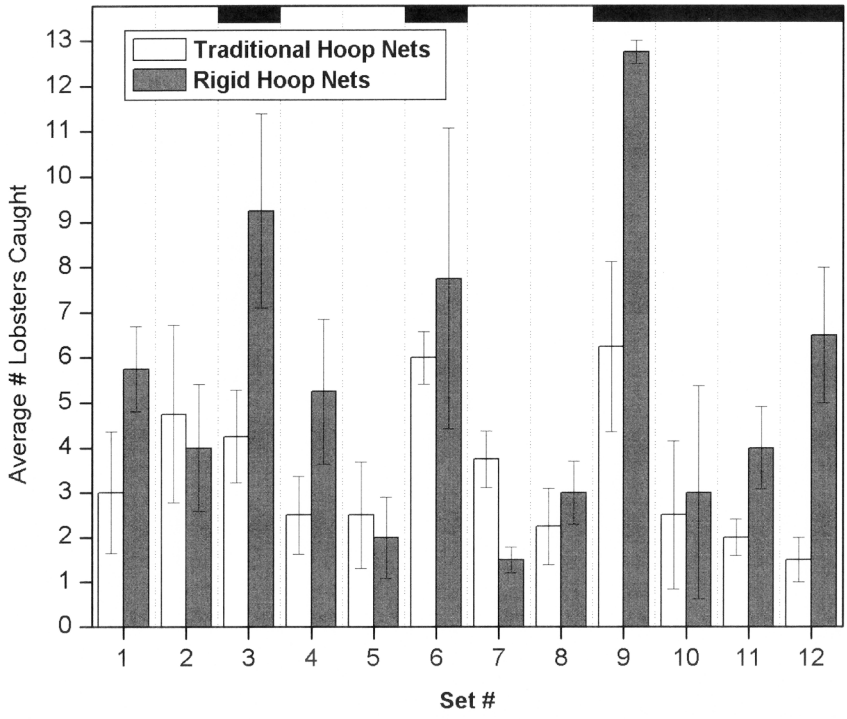

Figure 3. Average number of lobsters caught, by hoop net type, for each set of the study. A set is defined as a group of eight (4 traditional and 4 rigid) hoop nets. Traditional and rigid hoop nets are indicated by open and shaded bars, respectively. Black bars at the top of the graph indicate sets made between 2020LT-2130LT; this time interval begins approximately 30 minutes after sunset. Sets 1, 4, and 7 occurred during the second set time interval (2130LT-2300LT) and sets 2, 5, and 8 occurred during the third set interval (2300LT-0030LT). Error bars indicate standard error.

of these (a rigid) was empty of catch. Of the 96 nets deployed, 8 nets (8%) held no catch, 2 (2%) held only bycatch, and the remaining 86 nets (90%) contained at least one lobster. For all nets, the average catch per net was 3.7 ± 3.0 lobsters. The most lobsters caught in a single pull were 11 and 17 for traditional and rigid hoop nets, respectively.

Rigid hoop nets caught significantly more lobster (259) than traditional hoop nets (165) over the course of the study ($\chi^2 = 20.8$, $\rho << 0.001$), producing CPUE values of 3.4 lobsters per net and 5.4 lobsters per net for traditional and rigid hoop nets, respectively. Based upon the catch totals above, 57% more lobsters were caught in rigid hoop nets relative to traditional nets for the same time and effort. Approximately 17% of all lobsters caught were legal size.

The catch size declined over the course of the night ($r = -0.25$, $\rho = 0.01$) with the larger catches (11+ lobsters per net) always occurring within a few hours of sunset. The deployment distance from the jetty varied from 11.1 m to 68.8 m but no correlation existed between these distances and the number of lobsters caught ($r = -0.15$, $\rho = 0.15$). Finally, the depth of the set, roughly equivalent to position along the jetty, was uncorrelated with the catch size ($r = -0.06$, $\rho = 0.56$). Bycatch consisting of invertebrate and fish species (Table 1) occurred with both types of nets.

Species	Hoop Net Type					
	Traditional			Rigid		
	Total individuals	Total nets	Total nets with lobster & bycatch	Total individuals	Total nets	Total nets with lobster & bycatch
round stingray (*Urobatis halleri*)	15	9	6	8	5	4
rock crab (*Cancer* sp.)	4	4	3	8	7	5
California scorpionfish (*Scorpaena guttata*)	1	1	1	1	1	1
thornback ray (*Platyrhinoides triseriata*)	1	1	1			
spotted sand bass (*Paralabrax maculatofasciatus*)	1	1	1			
moray eel (*Gymnothorax mordax*)				1	1	1
sheep crab (*Loxorhynchus grandis*)				1	1	1

Table 1. Catch totals (# individuals) for non-targeted species by hoop net type. Columns list total individuals in all nets, total number of nets containing at least one individual, and the total number of nets containing both the given species and at least one lobster.

DISCUSSION

The rigid hoop nets used in this study were more efficient than traditional hoop nets; catching 57% more lobsters over the course of the study. The geometry of the

rigid nets, with their suspended wall of mesh, automatically retains lobsters that are attempting to swim horizontally from the net. In addition, the smaller diameter of the suspended ring, relative to the base ring, decreases the chance of a lobster escaping vertically from the net. Because of this design, catch loss is less of a problem than with the traditional nets. While a traditional hoop net can catch bag limits of lobsters, it is less forgiving during erratic pulls, since the traditional nets may allow lobsters to swim horizontally from the net before the traditional hoop net's basket shape is fully formed. During off-vertical or slow pulls, lobsters also may potentially swim directly from the top of a traditional hoop net.

How does the increased efficiency of a new (or modified) type of fishing gear affect the sustainability of the targeted fishery? If gear efficiency is the only thing that has changed about the fishery, and essential information is known about the target species, then answering this question can be relatively straightforward. Unfortunately, this is not the case with the California spiny lobster. New fishing platforms, most notably sea kayaks, have been adopted by lobster anglers. Anecdotal evidence also suggests that hoop netting is being promoted by the recreational fishing industry as a fun pastime for families without needing much equipment. Hoop netting for lobster is also a viable alternative for anglers affected by recent closures or restrictions in other fisheries (e.g., rockfish). Lastly, lacking a precise, regulatory definition of what constitutes a hoop net, the design will likely continue to evolve. The authors have observed homemade additions to the nets aimed at further increasing their ability to retain any catch. This trend towards an increasingly better mousetrap will only continue and will affect both lobster and bycatch catch rates.

These circumstances (increased access, increased interest in lobster fishing, increased marketing), coupled with increasing net efficiency, have the potential of increasing recreational effort and catch. However, our current knowledge is insufficient to quantify whether the recreational effort and, ultimately, catch actually are increasing. CDFG has taken steps to quantify the relative contribution of the recreational fishery to the total (recreational + commercial) catch and effort. Beginning in the 2008/2009 season, a new requirement for lobster report cards will allow CDFG to determine the number of people fishing recreationally for lobster, the number and location of lobster caught, the effort expended, and the gear used. The report card distinguishes between traditional and rigid hoop nets.

Finally, knowledge pertaining to the ecology and population dynamics of the California spiny lobster is quite limited. Distribution, movement patterns, and larval recruitment are currently unknown. In particular, the population biomass of lobsters off California is unknown. A stock assessment of the population is needed and would help to evaluate the recreational and commercial lobster fisheries in California, as well as the impact of traditional and rigid hoop nets on the stock.

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