New method for estimating unreported recreational lobster catch and effort improves estimates of total catch and effort for the fishery

Estimates of California spiny lobster recreational fishing rely on information reported on seasonal report cards (lobster cards), which are required for any person fishing for or taking lobster. At the end of each season, cardholders must submit their harvest information online or return their cards to the California Department of Fish and Wildlife (Department) by April 30. Despite public outreach efforts by the Department and a non-return fee, reporting rates have remain persistently low. Since the implementation of full season lobster cards in 2013, card reporting rates have ranged between 47% and 54%. Low reporting rates cause uncertainty around the estimates. In response, the Department conducted a survey of lobster cardholders in 2019 to test assumptions about non-reported fishing and determine whether methodologies should be improved for estimating effort and catch. Data were collected from both non-reported and reported 2018-2019 lobster cardholders to determine if there are any differences between reported cards and non-reported cards; and if differences exist, determine whether there are any within-group variability related to past fishery participation (based on full season lobster card purchase history). The sample size and description of each participation tier are provided in Table 1.

Table 1. Stratification, number surveyed, and responses for the 2019 sport lobster survey

Participation tier	Description	cardholders	# surveyed	Responses
One-time	No history of purchasing a lobster report card prior to the 2018-19 season	14,579	890	286
Infrequent	Purchased a card one to two times the past five seasons (i.e., from 2013-2014 to 2017-2018)	9,253	565	183
Sporadic	Purchased a card three to four of times the past five seasons	5,492	335	156
Avid	Purchased a report card each season, for the past five seasons	3,440	210	99
Total	--	32,764	2,000	724

Discussion and conclusion

The 2019 survey results revealed that 40% of the non-reporters did not fish compared to 20% for reporters, which nullifies the assumption that unreported fishing is the same as reported fishing and suggests the proportion of cards that did not fish is higher for non-reported cardholders than reported cardholders. Survey findings also suggest that stratification by participation tier improves the precision of non-reported effort and catch estimates. The study found that of all non-reported cards, more than half of those were held by one-time participants and, among all participation tiers, One-timers had the lowest average catch and effort.

Using 2019-2020 report card data, a comparison of the previous and new estimation methods showed that the previous method overestimated non-reported catch by 42.5% and overall recreational catch by 27.5%. In terms of effort, the previous method overestimated non-reported trips by 31.8% and overall number of trips by 18.8%. These results show that it is important to account for group difference in formulating the estimates.

While the new method provides an improved way for estimating total recreational effort and catch, the 2019 study of non-reported cards should be repeated periodically to determine if the initial findings are consistent. Initiating another creel survey would be beneficial as well to determine if there have been any changes in the recreational lobster fishing trends and average weight of lobsters retained (last creel survey was conducted in 2007). Updated length and weight data of lobster caught recreationally can further help to improve confidence and refine future estimates.

Synopsis of 2019 sport lobster survey findings

A total of 483 and 230 reported and non-reported 2018-2019 season cardholders, respectively, took part in the study. Of these, 95 reported and 93 non-reported cardholders from the 2018-2019 lobster season did not fish. There was a significant difference between the reporters and non-reporters that did not fish (X^2 = 34.61, df = 1, p-value = 4.04e-09). As shown in Table 2, a higher proportion of non-reported cards (40%) did not fish compared to reported cards (20%). The 95% confidence interval for the differences between these two proportions is 0.21 ± 0.07. Therefore, the initial assumption of no difference between reported and non-reported cards can be rejected.

The study also found that there is a statistically significant but "weak" association between whether a cardholder fished or did not fish and past participation level of non-reported cardholders (X^2 = 8.43, df = 3, p-value = 0.04; Cramer's V = 0.19).

For non-reported cards that did fish, a Kruskal-Wallis test showed that the mean ranks of lobsters kept per card are significantly different among the four participation tiers (H = 20.35, df = 3, p = 0.0001, ε^2 = 0.09). A Kruskal-Wallis test also detected significant differences in the mean ranks of trips taken by participation tier (H = 13.27, df = 3, p = 0.004, ε^2 = 0.06). This suggests within-group variations should be considered when estimating total effort and catch for non-reported cards.

Table 2. Summary of unused cards by reported and non-reported survey group

Summary statistic	Reported	Non-reported
Sample size	483	230
Sample proportion of cardholders that did not fish	0.20	0.40
Confidence level (95%)	0.20 ± 0.04	0.40 ± 0.06

Comparison of old and new methods for estimating recreational catch

Prior to the 2018-2019 season, recreational estimates for the lobster fishery assumed that there was no difference between non-reported fishing and reported fishing. Therefore, the proportion of reported cards where fishing effort was reported (i.e., "Fished") was assumed to be the same for the non-reported cards. The generic steps to estimate total catch and effort prior to the 2018-2019 season were as follows:

- Step 1: To obtain the estimated total number of Fished lobster cards, the reported proportion of Fished cards is multiplied by the total number of cards sold that season.
- Step 2: To estimate total catch, estimated number of Fished cards (Step 1) is multiplied by mean number of lobsters kept per reported card.
- Step 3: Estimated total weight is the product of estimated total catch (Step 2) and 1.6 lbs (mean weight of legal sized lobster derived from 2007 creel surveys).
- Step 4: Total estimated effort (number of trips) is the product of estimated number of Fished cards (Step 1) and mean number of trips per reported card.

A total of 34,804 lobster cards were sold in the 2019-2020 season and 17,563 (50% of sold cards), were reported. Of the reported cards, 76% were Fished, with a mean of 8.1 lobsters kept per card. Using the steps outline above, the estimated catch for the 2019-2020 sport season is around 216,898 lobsters or about 347,037 lbs. With this method, the recreational sector represented 31.4% of the total landings by weight (commercial + recreational). The total estimated recreational effort during the 2019-2020 season is about 92,579 fishing trips.

To reduce uncertainty related to low reporting and increase the accuracy of the Department's estimates, a new methodology was developed that uses a combination of returned card data and 2019 sport lobster survey findings to estimate the contribution of non-reported cards. This new method is outlined below.

- *Step 1: How many non-reported cards did NOT fish?*

  Estimated non-reported lobster cards that did not fish is the product of the total number of non-reported cards and survey results (40%) of non-reported cards that did not fish:

  17,241 x 0.40= 6,896 [rounded to nearest whole number]

- *Step 2: Of the number of non-reported cards that DID fish, how many belong to each participation tier?*

Participation tier	Proportion of non-reported cards	Estimated non-reported cards that fished
One-time	0.54	5586.3
Infrequent	0.28	2896.6
Sporadic	0.12	1241.4
Avid	0.06	620.7
Total	1.00	10,345

- *Step 3: Using the mean number of lobsters kept per reported card that DID fish by each tier, how many lobsters were caught by the non-reporters?*

Participation tier	Est. non-reported cards that fished	Mean kept lobsters per card	Est. non-reported catch
One-time	5,586	3.8	21,228
Infrequent	2,897	6.8	19,697
Sporadic	1,241	9.6	11,917
Avid	621	16.9	10,490
Total	10,345	--	63,332

- *Step 4: What is the total weight of lobsters kept recreationally?*
  a) Sum of all estimated lobsters caught by non-reporters (Step 3): 63,332 lobsters
  b) Number of lobsters caught by reporters (returned cards): 106,839 lobsters
  c) Total lobsters caught times mean weight (from creel surveys):
     170,171 lobsters x 1.6 lbs/lobster= 272,273.6 lbs

- *Step 5: What percent of overall catch is made up by the recreational fishery?*
  a) Total pounds (commercial + recreational): 759,226 lbs + 272,274 lbs = 1,031,500 lbs
  b) Recreational = 272,274 ÷ 1,031,500 = 26.4%

- *Step 6: Using the mean number of fishing trips per reported card that DID fish by each tier, how many fishing trips were taken by the non-reporters?*

Participation tier	Est. non-reported cards that fished	Mean number of fishing trips per card	Est. number of fishing trips
One-time	5,586	2.4	13,407
Infrequent	2,897	3.3	9,559
Sporadic	1,241	3.9	4,842
Avid	621	5.7	3,538
Total	10,345	--	31,346

- *Step 7: What is the estimated total effort (fishing trips)?*

a) Total effort (number of trips by reporters + est. number of trips by non-reporters):
46,595 trips + 31,346 trips = 77,941 trips