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Source: Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science, 2010(2010) : 47-59

Published By: American Fisheries Society

URL: https://doi.org/10.1577/C08-030.1

Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 2:47–59, 2010

DOI: 10.1577/C08-030.1

Fisher-Collected Sampling Data: Lessons from the New Zealand Experience

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Abstract.—The New Zealand fishing industry has adopted a strategy of using fishers to collect biological sampling data from their fisheries, usually on a voluntary basis. This approach can be adopted for data-poor fisheries to obtain data that would otherwise not be available. This article describes a wide range of such programs implemented in fisheries spanning a period of 15 years. This article also reveals the designs employed, how these data have been used in stock assessment and fisheries management situations, and some of the problems encountered in administering these programs. I conclude that while these programs need supervision and support in order to succeed, the benefits that can accrue are considerable. These benefits include a dynamic sampling design that should ensure good representation of the fishery and the involvement of fishers in collecting the data used to manage their fishery.

Low-information or data-poor fisheries present a number of important and interesting challenges, not the least of which is to improve the level of information available from the fishery. A possible route to this goal is to enlist fishermen into the activity of data collection, with the hope that good information can be collected at a reasonable cost. Fisher-collected sampling data have the potential to be a good representation of the fishery if the sampling program is well designed. This is because the sampling activity can be exactly tuned to the fishing activity, resulting in a program that is not only representative (provided that a good cross-section of fishers has been recruited to the program) but also dynamic in the sense that it will automatically accommodate changes in fishing activity as they occur.

An interesting side benefit that derives from enlisting fishermen in the business of data collection is the requirement to explain to them clearly the need for the data and the tactics of the design. My experience is that this part of the process, while difficult, is rewarding and usually results in a high level of stakeholder acceptance of the resulting data and consequent analyses.

The management of New Zealand's commercial fisheries has been based on an individual transferable quota model since 1986 (or since 1990 for rock lobster *Jasus edwardsii*). One of the major benefits of such a management system is that there are strong incentives for quota owners to take a much more direct interest in the resource (Costello et al. 2008). The value of quota is an important part of the business of fishing, and it pays to look after the resource—much like the ownership of a house encourages maintenance and upkeep. Fishers want to get involved in the management of their fisheries at all levels, and collecting data that are integral to understanding the fishery is an excellent way to get stakeholders involved.

Costs are an issue that, although ubiquitous across all fisheries, has an important component in expression in New Zealand, where all costs (including research) are directly attributed to the benefiting fishery through a process known as "cost recovery." This means that any fishery sampling program, including those commissioned by the Ministry of Fisheries, are directly billed to the quota owners (proportionate to the size of their quota holdings) whose fishery is being sampled. Therefore, there is a strong incentive in New Zealand for the fishing industry to find cost-effective ways to obtain the basic information required to manage these fisheries while still maintaining the quality standard required by the Ministry of Fisheries. This particularly applies to low-value inshore fisheries, where historical information has not been collected in a consistent or routine fashion.

Representative length and age data from fishing activity are a central part of any data collection scheme designed to support the stock assessment and management of fish stocks. Two basic problems are associated with these programs: their general high cost and the difficulty of ensuring that the sampling program is representative of the fishery being sampled. Linking a sampling program directly to fishing activity and allowing the fisher to collect the data within the context of the fishing activity have the potential of obtaining representative data at a reasonable cost. In this article, I describe several such programs that have

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Received October 26, 2008; accepted August 3, 2009
Published online March 18, 2010

been set up in New Zealand. I give some indication of how these programs have fared (in terms of their success in obtaining useful data that can be used in a stock assessment), and then I draw some general conclusions based on how well these programs have achieved their objectives.

Experience with fishery sampling programs has shown that most agencies collect these data either in sheds (where fish are landed) or at sea by using independent observers whose sole job is to collect the data. These latter programs have the shortcomings of high cost and the frequent difficulty of placing observers on the vessel, either because of a shortage of space or reluctance by the operator to take on an observer. Market (sometimes called "shed") sampling programs have the advantage of potentially reduced costs due to a greater concentration of fish for sampling. However, this advantage comes at the cost of not being able to identify the specific locations where the fish have been taken. As well, market sampling may be impractical if fish are processed or cut at sea. Fisher-collected length and age data have the potential to overcome all these problems, at the cost of potentially losing the independence of the sampling activity.

Fisher-collected data are defined as samples taken as part of the fishing activity and then either measured on board at the end of the activity or sequestered in an identified bin for later measuring on shore. This is effectively a "two-stage" sampling approach, where the primary sampling stratum is the fishing trip and samples are taken from effort events associated with the trip. When biological samples are processed on board, they are measured by either the fisher or a deckhand. The key is to be able to link the biological sample to the record of fishing effort that is associated with the sample. If the program is well designed, representative sampling across time and space (as well as other potential stratification parameters, such as depth) is ensured because the sample is collected over a large proportion of the fishing effort used to capture the species in question.

Overall Design of Fisher-Collected Data Sampling Programs

Sampling by observers on a fishing vessel is by definition "intensive," as noted by Starr and Vignaux (1997). That is, a large proportion (often nearly 100%) of the fishing events is sampled within a "trip" (all the fishing events between leaving and returning from port). However, it can be shown that there is often more sampling variability between trips than between fishing events on the same trip. This effectively means that fishing events on the same trip are correlated and that the true sample size resulting from such a design is probably less than the actual number of fishing events sampled. This problem can be overcome by sampling from a greater number of trips, thus adding to the overall cost and making this sampling tactic relatively expensive, primarily due to the need to use dedicated observers.

Fisher-collected data tend to be "extensive" (Starr and Vignaux 1997); that is, covering a larger number of trips but generally collecting far less data per sampling event. For instance, the sampling program for the New Zealand rock lobster specifies that only four pots in a string of 100–150 need to be sampled, while an observer on an equivalent rock lobster trip might sample 75–100 pots depending on the number of lobsters in each pot. The contrast is between intensive observer sampling, where sampling is done thoroughly across most fishing events within a single trip, and extensive sampling by fishers, where a smaller number of fishing events per trip are sampled with fewer fish (compared to intensive sampling) but a wider range of trips are selected. Both designs are defensible and represent possible extremes in a continuum of sampling strategies.

The basic design approach to extensive sampling has already been alluded to: fishing events within a trip are selected, usually systematically (although random selection of events is sometimes possible), and fish from that event are sampled either as a total sample or a randomly selected subsample. Alternatively, when the number of fishing events within a trip is relatively small, a randomly selected sample of fish is taken from nearly every fishing event. These design distinctions will become more apparent as practical examples of extensive sampling are discussed below for a number of New Zealand fisheries that use this sampling approach.

Scale and Design of Fisher-Collected Sampling Programs in New Zealand

At least 19 separate fisher-collected sampling programs targeted at finfish or shark species can be identified as having operated in the New Zealand Exclusive Economic Zone beginning in the early 1990s and extending to the present time (Table 1). These programs have covered most of the fishable waters in the New Zealand Exclusive Economic Zone (Figure 1) over a period of 13 years, having sampled nearly 56,000 fishing events from over 12,000 trips. During the 13 years, 255 unique vessels have participated in these programs. Similarly, nearly 200,000 pot lifts over 55,000 sampling days have measured 900,000 lobsters in the New Zealand rock lobster fisheries within nine

TABLE 1.—Finfish and shark fisher-collected sampling programs operating in New Zealand from 1 October 1994 to 30 September 2007, showing program location, fishing method, and primary species targeted. Locations are shown in Figure 1. Also shown are the number of unique vessels participating over the history of each program, the total number of trips with sampling events, and the total number of effort events sampled.

Fishing method and region	Primary species	Start year	End year	Number of vessels	Number of trips	Number of sampled events
Northern North Island						
Bottom longline	(Bluenose) *Hyperoglyphe antarctica*[b]	1994–1995	Ongoing	44	1,048	3,161
Bottom longline	(Snapper) *Pagrus auratus*	2001–2002	2003–2004	6	168	480
Bottom trawl	(Splendid alfonsino) *Beryx splendens*[b]	2001–2002	2004–2005	2	23	72
Bottom trawl	(Rubyfish) *Plagiogeneion rubiginosum*[b]	2002–2003	2002–2003	1	1	4
Bottom trawl	(Ling) *Genypterus blacodes*[b]	2002–2003	2005–2006	1	70	153
Danish seine[a]	Snapper	2002–2003	Ongoing	3	252	809
East coast of South Island–inshore						
Bottom longline	Bluenose[b]	1994–1995	Ongoing	18	135	240
Bottom trawl	Mixed species	1999–2000	Ongoing	43	1,165	3,877
Setnet	(Rig) *Mustelus lenticulatus*[b], School shark (tope) *Galeorhinus galeus*[b], (Elephantfish) *Callorhynehus milii*[b]	1994–1995	Ongoing	47	2,018	2,482
East coast of South Island–offshore						
Bottom longline	Ling	1994–1995	Ongoing	15	168	13,830
Bottom trawl	(Hoki) *Macruronus novaezelandiae*	1998–1999	2005–2006	32	413	13,625
Bottom trawl	Bluenose[b]	1997–1998	2003–2004	5	37	135
Bottom trawl	(Orange roughy) *Hoplostethus atlanticus* and black oreo *Allocyttus niger*	1997–1998	2005–2006	21	169	1,085
Southern South Island						
Setnet	School shark (tope),[b] rig,[b] elephantfish[b]	1995–1996	Ongoing	8	269	493
West coast of South Island						
Bottom longline	Bluenose[b]	1994–1995	Ongoing	24	530	1,143
Dahn line	Bluenose[b]	2002–2003	2005–2006	5	29	32
Bottom trawl	Mixed species[b]	2000–2001	Ongoing	40	4,399	12,320
Setnet	Rig,[b] school shark (tope)[b]	1995–1996	Ongoing	25	1,189	1,573
West coast of North Island–southern						
Setnet	Rig,[b] school shark (tope)[b]	1995–1996	Ongoing	21	270	389

[a] Also sampling in Tasman and Golden bays at the top of South Island.
[b] Indicates projects within the adaptive management program.

quota management areas (QMAs; Figure 2) over a 15-year period (Table 2). These statistics indicate that fisher-operated sampling programs can be mounted on a large scale and potentially can supply sufficient data to monitor the biological characteristics of a fishery.

The following paragraphs describe the basic designs of four programs as examples of the types of data that are being collected and the method by which they are collected. Each program is an example of the extensive sampling approach, although in some cases every fishing event executed by a participant is expected to be sampled, whereas in other cases only a subsample of fishing events is required. Species names are provided in Table 1.

Rock Lobster Potting Fishery

Typically, an operator in the rock lobster potting fishery will run a string of 100–150 pots that are placed in locations where lobsters are expected to be caught. This is a fully developed fishery where good locations are well known and have been fished continuously for decades. Participants are asked to tag four “average” or “representative” pots, stipulating that the selected pots should be fished as all others, including moving them along the coast as the season progresses. Every lobster in each tagged pot is measured, along with taking the sex and maturity state of female lobsters. Auxiliary information is also collected, including depth, soak time, and finer-scale location information.

Bluenose Longline Fishery

The bluenose longline fishery is a small-boat fishery operating in deep water (300–500 m) but usually less than 50 km from shore. Fishers are supplied with a random number table, stipulating a beginning hook number or time from the beginning of the haul. When that hook is reached (or when the allotted time has elapsed), the fisher is then asked to select the next 10 bluenose. The 10 bluenose are sampled biologically (length, sex, and maturity) or sequestered into a tote (bin) for later sampling by an on-shore technician. Every fishing event in a trip is expected to be sampled, and detailed information such as that pertaining to location of set, depth of set, and the designated target

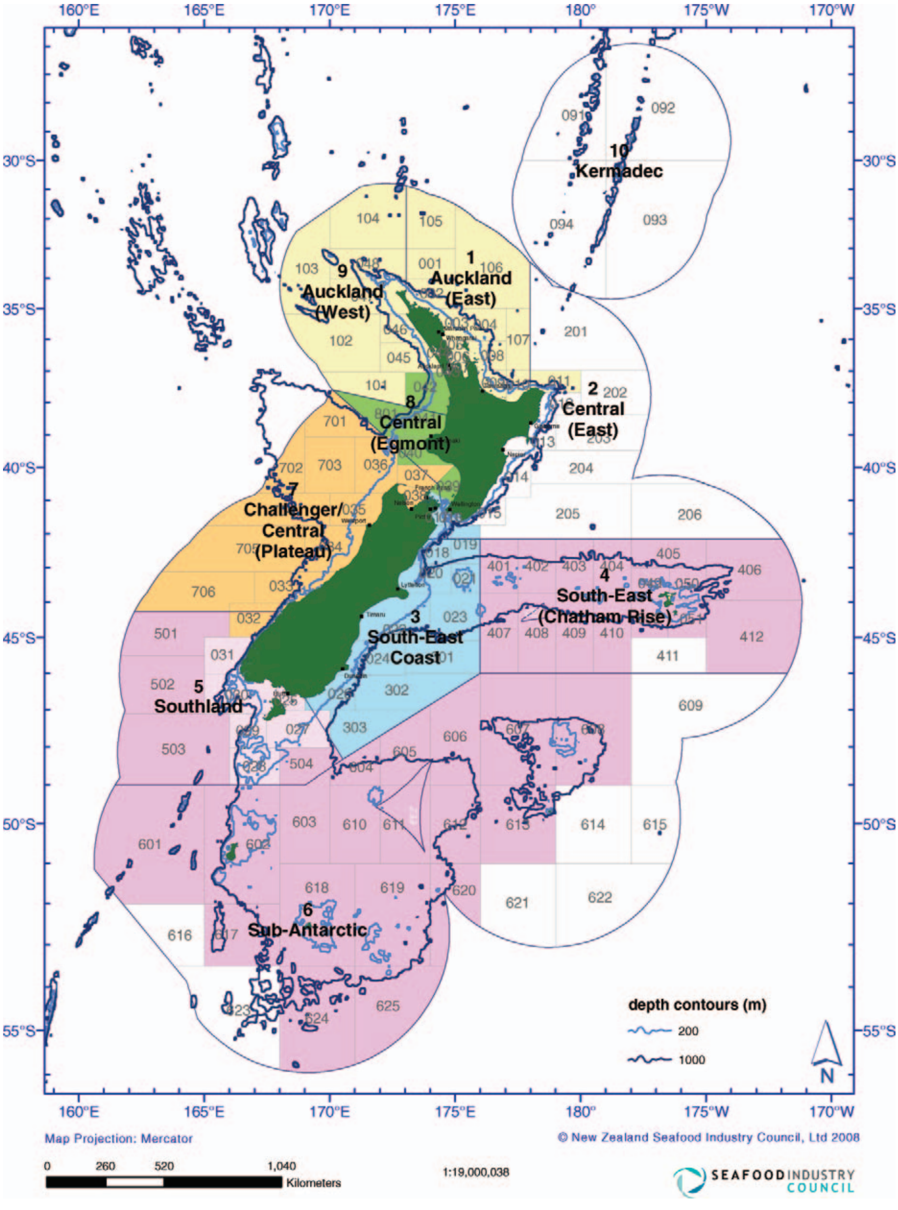

FIGURE 1.—Map showing the location of fisher-collected sampling for finfish and shark species in New Zealand waters. All programs are listed in Table 1.The 200- and 1,000-m contours are indicated. The color code for each region is as follows: yellow = northern North Island; light blue = east coast of South Island–inshore; purple = east coast of South Island–offshore; light purple = southern South Island; orange = west coast of South Island; and light green = west coast of North Island–southern.

species is also obtained. A fisher usually does one to five sets per trip, but more sets are possible. Otoliths are usually taken from two or three of the sets depending on the fisherman.

Setnet Fishery for Rig

The setnet (i.e., fixed gill-net) fishery for rig (a small inshore shark) is also a small-boat fishery operating near shore (usually 4–11 km from shore) and targets a range of shark species, including the rig, school shark (also known as tope), spiny dogfish *Squalus acanthias*, and elephantfish. The setnets are usually anchored near the bottom, and fishers are asked to sample 10 rig, 10 school sharks and 10 elephantfish from a specified location on the net. These sharks are measured to the nearest 5 cm, and the sex and presence or absence of

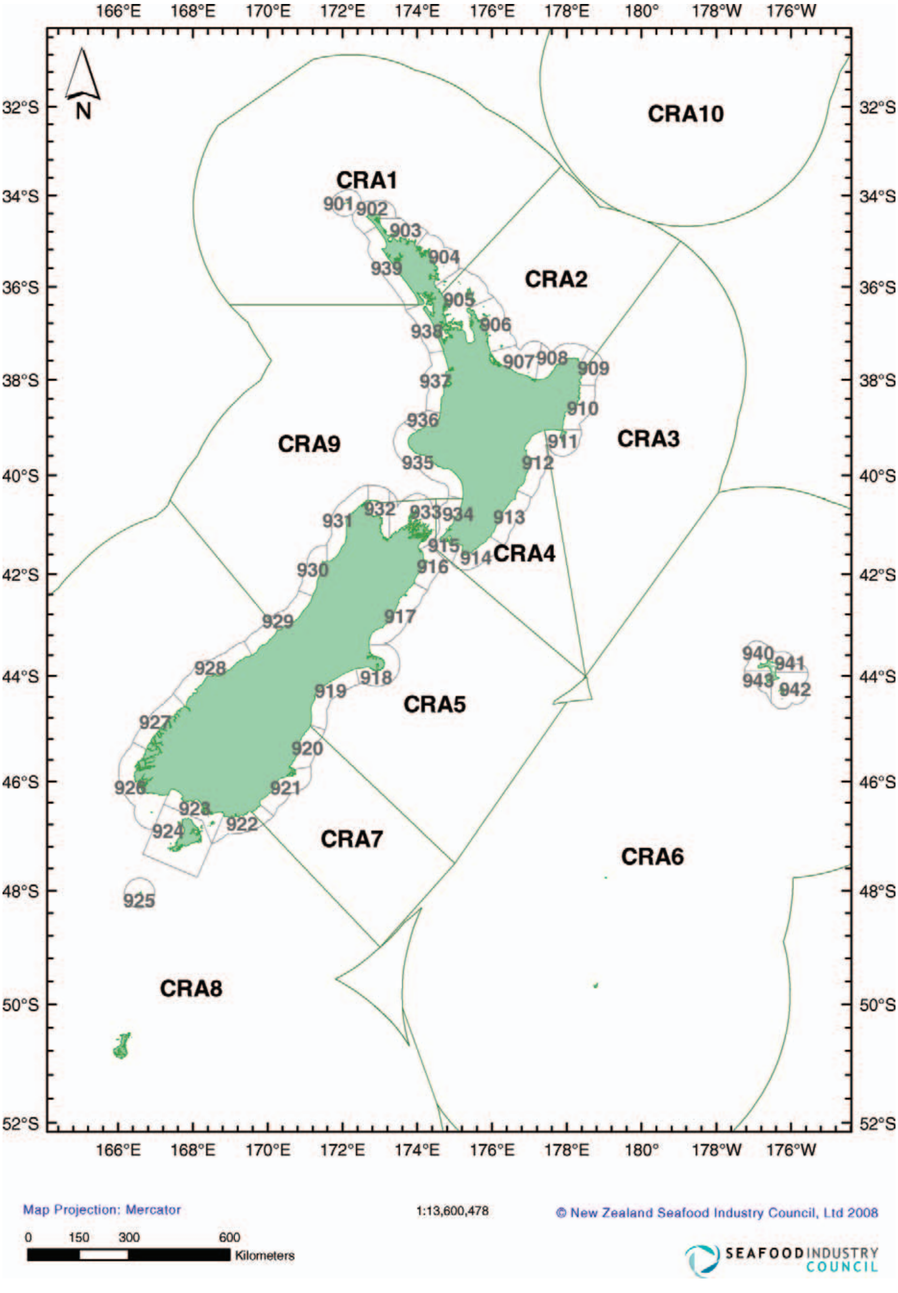

FIGURE 2.—Location of the New Zealand rock lobster (also known as "crayfish," CRA) quota management areas (QMAs) 1–9. The programs operating in each of these QMAs are listed in Table 2. The small coastal boxes are the rock lobster statistical areas.

claspers (in male sharks) are recorded. These data are important because sharks are processed at sea to prevent contamination of the flesh with urea, and there is no way to obtain the sex or true length of the fish as they are eviscerated with the head, tails, and fins removed.

Mixed-Species Bottom Trawl Fishery along the East Coast of South Island

The mixed-species bottom trawl fishery along the east coast of South Island is another small-boat inshore fishery operating primarily in the depth range from 70

TABLE 2.—Rock lobster logbook programs operated in New Zealand from 1 April 1994 to 31 March 2008 in each of nine rock lobster (also known as "crayfish", CRA) quota management areas (QMAs; Figure 2). Also shown are the number of sampling days, the number of pots sampled, and the number of lengths measured.

Rock lobster QMA	Start year	End year	Number of days	Number of pots	Number of lengths measured
CRA 1	1993–1994	1995–1996	143	550	1,142
CRA 2	1993–1994	Ongoing	17,326	64,564	156,509
CRA 3	1993–1994	1998–1999	1,144	4,260	32,408
CRA 4	1997–1998	1998–1999	684	2,609	12,249
CRA 5	1994–1995	Ongoing	12,138	45,665	324,370
CRA 6	2001–2002	Ongoing	2,011	5,127	11,143
CRA 7	2001–2002	2003–2004	301	802	3,980
CRA 8	1993–1994	Ongoing	20,214	64,277	341,437
CRA 9	1996–1997	Ongoing	1,020	3,896	12,322

to 400 m. It targets a range of species, not all of which are sampled. The fisher is asked to sample at least twice per day from a range of six species (elephantfish, rig, giant stargazer *Kathetostoma giganteum*, New Zealand sole *Peltorhamphus novaezeelandiae*, tarakihi *Nemadactylus macropterus*, and red gurnard *Chelidonichthys kumu*), measuring and recording sex from 30 fish/sample depending on the species. Fishers are instructed to take their fish from an appropriate sampling point tailored to their vessel, and they are shown how to select fish randomly from the tow. A tow is selected randomly within a day based on a random number table of time of day, and the sampled tow is the first tow after the randomly selected time that contains at least 10 fish of the species to be sampled.

Application of Fisher-Collected Sample Data to Fishery Management and Stock Assessment in New Zealand

This section documents some instances in New Zealand where fisher-collected sampling data have been used in a practical manner to assist stock assessments or other management decisions.

Rock Lobster Quota Management Area 8

Quota management area 8 for rock lobsters (referred to as CRA 8 because rock lobsters are also known as "crayfish" in New Zealand) is located in the southwest corner of South Island and includes Stewart Island (Figure 2). Fisher-collected length-frequency data have formed an integral part of the New Zealand rock lobster assessments since the late 1990s (Starr and Bentley 2002; Breen et al. 2006; Haist et al. 2009) and have been collected routinely in CRA 8 since 1993. These data are used in a purpose-built, length-structured population assessment model (Haist et al. 2009) along with observer length-frequency samples when available. Both types of data are used in an equivalent manner in the model but are separately fitted when they are both available. An example of such a fit is shown in Figure 3, where observer catch sampling and fisher logbook data from the same year and model period are fitted simultaneously. These data are used to estimate the selectivity of the pots and the relative year-class strength of recruits and to assist the model growth parameter estimates. Fisher-collected length-frequency data have been used in every rock lobster stock assessment undertaken in New Zealand since 1997 and are integral to the assessments of CRA 2, 5, and 8 (Figure 2). The assessments undertaken for CRA 1, 3, 4, and 7 are mainly based on observer sampling, but all of these assessments also make use of fisher-collected data to a lesser extent.

Elephantfish along the East Coast of South Island

The majority of the finfish and shark fisher-collected sampling data have been collected in support of the adaptive management programs (AMPs) instituted by the New Zealand Ministry of Fisheries in 1991 as a way of experimentally increasing total allowable commercial catches (TACCs) in return for increased voluntary data collection and closer monitoring of these fisheries. These programs are monitored in a variety of ways, mostly through biannual analyses of catch-per-unit-effort (CPUE) data and in some instances by inshore random stratified trawl surveys. Each AMP typically has also included some form of fisher-collected sampling information (Table 1). The success of these programs has been mixed, with the majority of AMPs faltering in recent years through attrition in the participants and thus failing to adequately maintain good coverage. An example of the data collected by the AMPs is presented in Figure 4, showing reasonable sets of elephantfish length-frequency data that could, in the future, be incorporated into a stock assessment to help determine the fishery selectivity. Most of the programs marked with an asterisk in Table 1 will have length-frequency distributions available similar to the plot in Figure 4, giving at least a good start towards

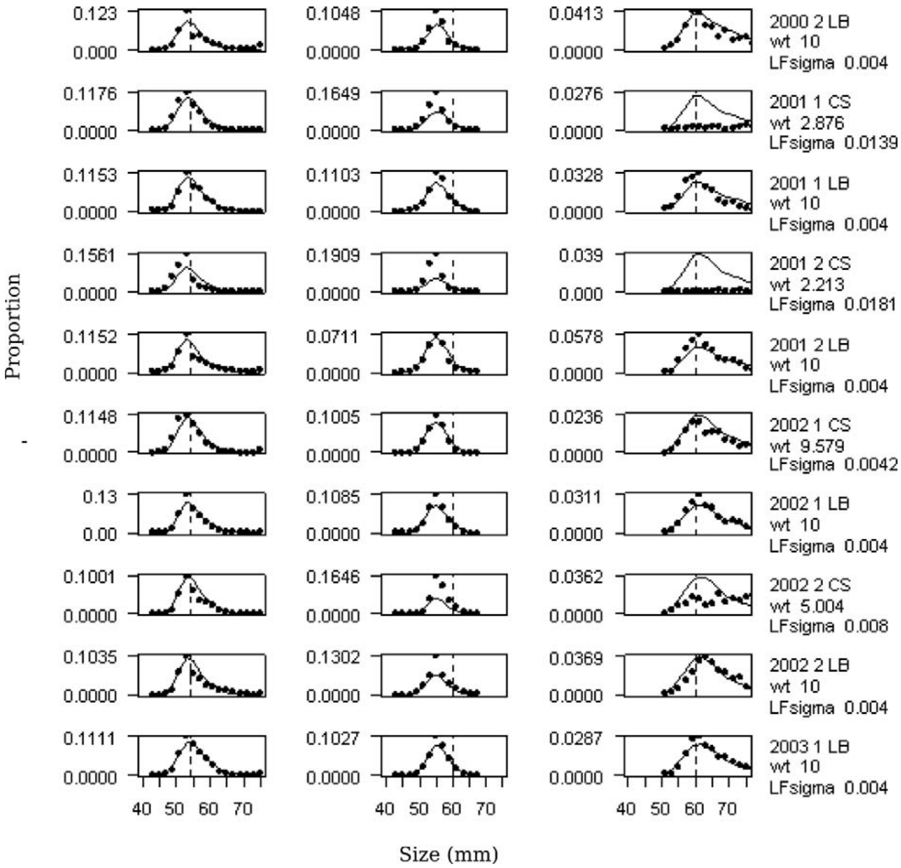

FIGURE 3.—Examples of model fits to length-frequency data collected by fisher-operated logbooks (LB) and observer catch sampling (CS) with a length-structured population model used to assess the potting fishery in New Zealand rock lobster quota management area 8 (i.e., CRA 8 in Figure 2; Haist et al. 2009). Observed data (in 2-mm length bins) are shown as dots, whereas the model-predicted fits are shown as lines. The left column is males, the center column is immature females, and the right column is mature females. The sum of the density for each row of three plots has been normalized to 1.0. Sampling period is indicated next to model year (1 = April–September; 2 = October–March); wt = relative weight for sample when fitting; LFSigma = calculated variance associated with the sample.

estimating the relevant selectivity in a future stock assessment.

Rig along the East Coast of South Island

The QMA for rig along the east and south coasts of South Island is referred to as SPO 3 (Figure 1) and participates in the AMP described above. A stock assessment for this population based on an age-structured model was recently presented to an internal review committee chaired by the New Zealand Ministry of Fisheries (P. Cordue and P. J. Starr, unpublished data). Figure 5 shows this model's fits to some of the length-frequency data collected by the fisher-collected sampling program in the setnet fishery, which is the primary rig harvester within SPO 3. The assessment concluded that although the length-frequency data were adequate for specifying the selectivity of the setnet fishery harvesting rig, they were inadequate for estimating year-class variation because of the strong interannual variation in estimated length distributions and the likely nonrepresentative nature of the sampling. An earlier stock assessment undertaken for rig from the west and north coasts of South Island (management area SPO 7; also in the AMP at the time) also made use of fisher-collected length information to estimate the selectivity of setnet and trawl fisheries (P. J. Starr and A. Hicks, unpublished data).

Bluenose

A comprehensive review in early 2008 of all bluenose populations in the New Zealand Exclusive Economic Zone demonstrated that the five major

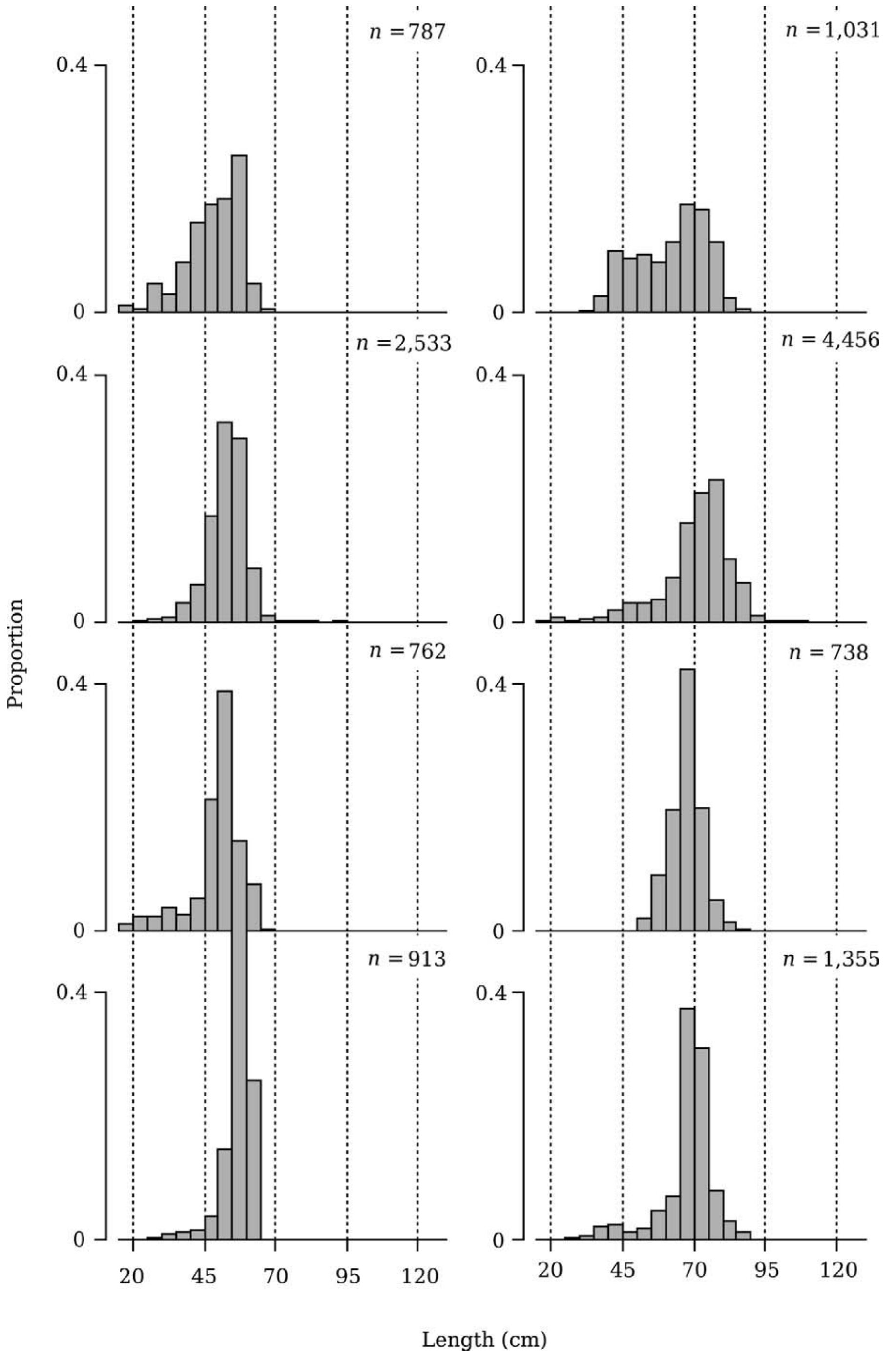

FIGURE 4.—Frequency distributions for male and female elephantfish scaled to the reported sampled catch from fisher-collected logbooks for trawls operating along the east coast of South Island, New Zealand. Length data are binned into 5-cm length–classes, and sampled fish are scaled relative to the total commercial landings by month and statistical area. The sum of the two sex distributions in each fishing year equals 1.0.

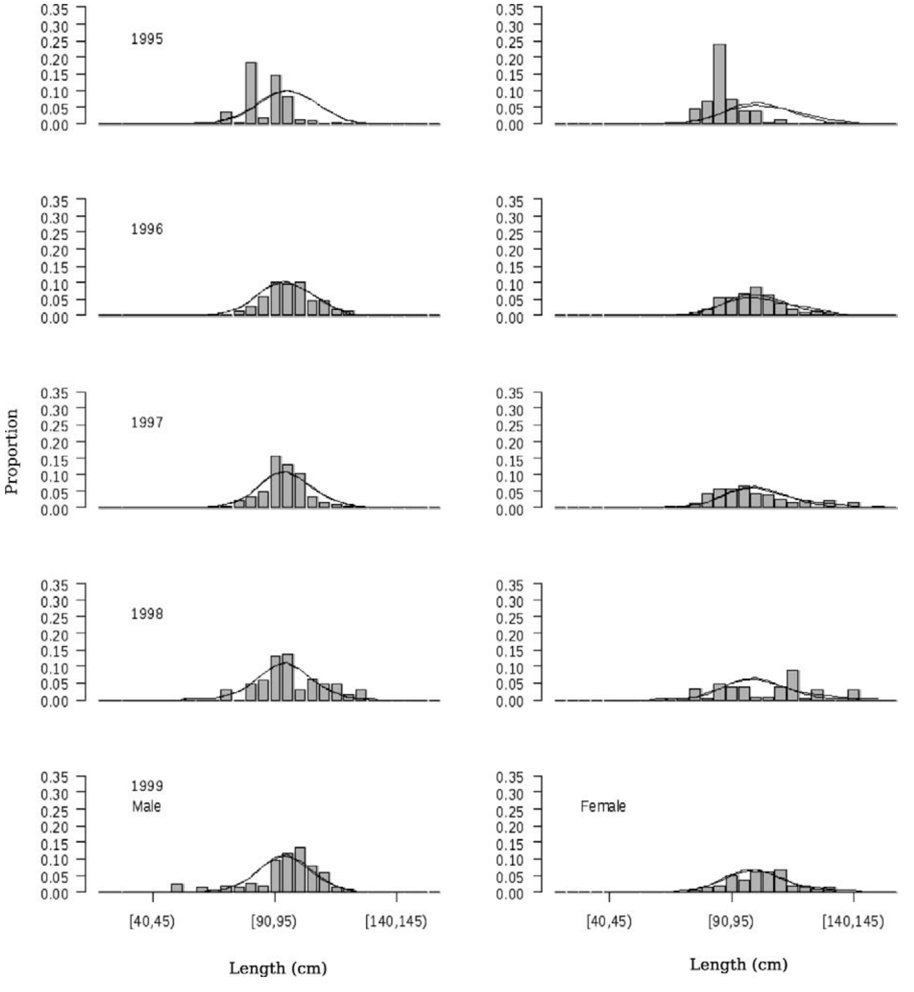

FIGURE 5.—Fits of an age-structured stock assessment model to length data collected by a fisher-operated sampling program (1994–1995 to 1998–1999) from the setnet fishery for rig along the east coast of South Island, New Zealand. The predicted values for two alternative model hypotheses are depicted with a solid line and a dashed line. Observed values (in 5-cm length bins) are shown as histograms.

fisheries for this species all showed an approximate 60% decline in CPUE from 2002 to 2007 (New Zealand Ministry of Fisheries 2008). Bluenose are managed in five separate areas within the New Zealand Exclusive Economic Zone; all of these areas are in the AMP and several have been in the program since the mid-1990s (Table 1; Figure 1). The presence of this species in the AMP was the reason the CPUE decline was detected, and it is unlikely that the bluenose would have received this level of scrutiny had it been outside of the AMP. The fisher-collected sampling programs that support these AMPs helped to corroborate the strong decline in CPUE, with a declining trend in male mean lengths in four sampled fisheries with sufficient data and a possible downward trend in mean length for females in the same four fisheries (Figure 6). The AMP fisher-collected sampling programs for bluenose also collected a large number of otoliths since the mid-1990s, which have yet to be aged (Table 3). The reason for the failure to age these otoliths has been that the aging protocol for this species was still being worked out, a process which has recently been resolved (P. L. Horn, H. L. Neil, P. M. Marriott, L. J. Paul, and C. Francis, New Zealand Ministry of Fisheries, unpublished data). Therefore, this large pool of over 12,000 otoliths represents an extraordinary historical resource that can potentially be used to corroborate the recent CPUE declines, with samples available from both before and during the period of decline.

The fisher-collected bluenose sampling program also

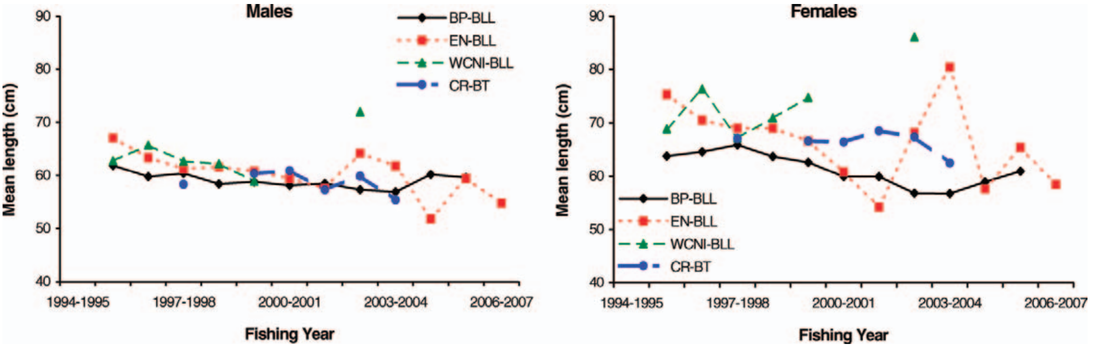

FIGURE 6.—Mean length of male (left panel) and female (right panel) bluenose by fishing year (1 October–30 September) across four of the bluenose industry logbook programs in New Zealand. Fishery codes are as follows: BP-BLL = Bay of Plenty bottom longline (north coast of North Island); EN-BLL = east Northland longline (north coast of North Island); WCNI-BLL = west coast of North Island longline; and CR-BT = Chatham Rise bottom trawl (Figure 1: area 4).

requests the fisher-samplers to make a judgment about the maturity of the female fish. These data have been summarized across all years in Figure 7 to show that these amateur samplers are capable of providing credible biological information. Female bluenose from this program attain 50% maturity at around 60–62 cm, which is reasonably consistent with previous estimates of around 65 cm (Horn et al., unpublished data). Based on data from this program, peak female maturity was shown to occur in the late autumn and early winter, which is also consistent with previous information (Horn et al., unpublished data).

Comparison with Observer Data

Starr and Vignaux (1997) attempted to validate fisher-collected rock lobster data by comparing estimated length frequencies stratified by statistical area and month with equivalently collected dedicated observer data. They compared 40 strata spanning 3 years in month–statistical area combinations for three statistical areas of CRA 8 (Figure 2); 35 of these 40 comparisons were scored as "good" or "acceptable." Starr and Vignaux (1997) concluded based on these comparisons "...that a fisher-based voluntary logbook program can collect accurate and useful data for use in stock assessments similar to those from research [= observer] catch-sampling programs." They also concluded that "CPUE estimates based on the length frequencies collected by the voluntary logbooks are comparable to CPUE estimated from the compulsory catch–effort data collected by the New Zealand Ministry of Fisheries." Starr and Vignaux (1997) noted that the comparability between the sample and fleet CPUEs supported the conclusion that the sampling

TABLE 3.—Number of bluenose (BNS) otolith samples available from industry logbook programs by fishing year and region of sampling in New Zealand (QMA = quota management area; BNS 1 = combined areas 1 and 9 on Figure 1; BNS 2 = area 2 on Figure 1; BNS 3–ECSI = area 3 on Figure 1 [east coast of South Island]; BNS 3–Chatham Rise = area 4 on Figure 1; BNS 7 = area 7 on Figure 1; BNS 8 = area 8 on Figure 1).

Fishing year	QMA						
	Unknown	BNS 1	BNS 2	BNS 3–ECSI	BNS 3–Chatham Rise	BNS 7, 8	Total
1994–1995	—	—	20	—	—	70	90
1995–1996	—	228	—	—	—	61	289
1996–1997	13	200	83	—	—	42	338
1997–1998	—	629	189	37	365	29	1,249
1998–1999	22	1,099	147	—	69	106	1,443
1999–2000	39	1,643	19	40	120	95	1,956
2000–2001	980	798	—	21	331	3	2,133
2001–2002	930	130	10	219	181	—	1,470
2002–2003	276	582	—	—	108	20	986
2003–2004	57	863	—	66	—	37	1,023
2004–2005	—	476	20	—	—	—	496
2005–2006	—	557	47	—	—	—	604
2006–2007	—	30	—	—	—	—	30
Total	2,317	7,235	535	383	1,174	463	12,107

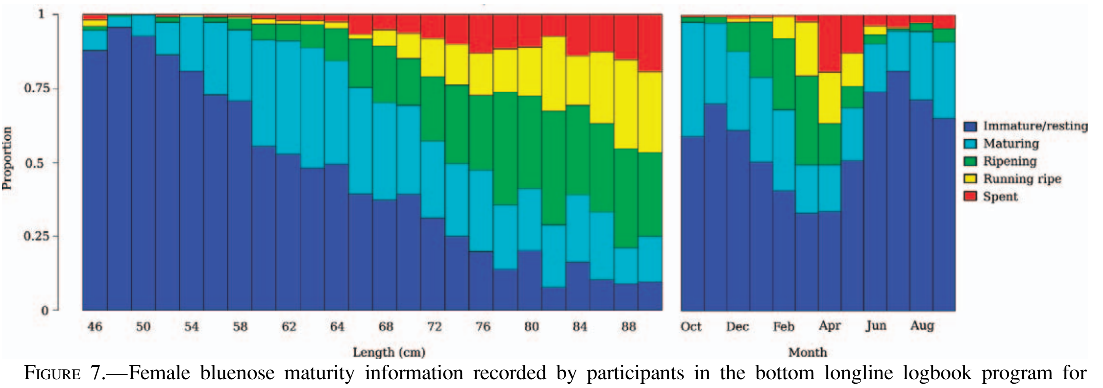

FIGURE 7.—Female bluenose maturity information recorded by participants in the bottom longline logbook program for bluenose quota management area 1 (BNS 1; north coast of North Island): the proportion of immature females (solid blue) by 5-cm length bins for the period January to April (left panel); and the proportion of immature females (solid blue) by month of sampling (right panel).

design of the fisher-collected data had probably achieved the goal of representative sampling of the fleet.

Bentley et al. (2002) used the fisher-collected rock lobster length-frequency data from CRA 8 to construct an operating model to calculate the optimal sampling effort for observer and fisher-collected length-frequency data in the rock lobster potting fishery. Bentley et al. (2002) concluded that there should be a target participation level of 30% (percentage of active vessels fishing lobster) per rock lobster QMA (Figure 2) per year for the fisher-collected length-frequency data. This level of participation has since been used to evaluate the success of the rock lobster fisher-collected sampling data, and the resulting length frequencies have performed well when used in assessment models (Haist et al. 2009).

Limitations and Problems with the Data

Collecting representative fisheries data though voluntary programs based on fisher participation should, in principle, be straightforward as long as participation levels remain high and as long as the data are collected according to design. However, this prescription is breached more often than not, and such programs frequently fail to meet the twin goals of good participation and representativeness. Our experience in New Zealand is that commercial stakeholders often readily agree to become involved in fisher-collected sampling programs, usually because they are unaware of the extent of the commitment required and they underestimate the required resources. Such programs have little hope of succeeding without a dedicated supervisor who communicates regularly with the participants, checks through the turned-in forms, and generally supervises the program. This should be considered a minimum requirement. It also helps if there is also a technician who can move between the participants on their vessels to demonstrate what has to be done. Finally, incentives are required—usually monetary—and should be distributed to the participants. Such incentives clearly move the program out of the "voluntary" aspect, but adopting such a strategy is probably the key to ensuring that the program will continue long enough to collect information that can be considered a time series of data.

When a fisher-collected sampling program is run well by adhering to the sampling design and maintaining a high level of participation, it will likely obtain data that are equivalent to or potentially superior to other traditional sampling methods, such as on-board observers or on-shore sampling, because such a sampling regime should be fully representative due to its dynamic design. It is also likely that the total cost will be less than an equivalent program run in a more traditional manner, even though employing a supervisor, a technician, or both and paying the participants will incur significant costs. However, such benefits will be lost for programs where the design is not followed or where participation flags.

Tables 4 and 5 show how some of these programs have fared over time: several programs, particularly the North Island bluenose fishery and the setnet fisheries along the east and west coasts of South Island, show a considerable drop in the number of vessels participating in the programs as well as in the sampled effort. These trends can be reversed, as can be seen in the setnet programs for the east and south coasts of South Island; the programs completely disappeared in the 1998–1999 fishing years, only to be resurrected in the following fishing year after an intensive period of recruiting new participants. The lesson here is that these programs require dedicated supervision in order to succeed.

The other lesson is that it is naïve to think that these

TABLE 4.—Number of vessels (V) and total effort (E) monitored by fishing year (1 October–30 September) for seven of the fisher-collected sampling programs listed in Table 1 (WCSI = west coast of South Island, New Zealand; ECSI = east coast of South Island; SCSI = south coast of South Island). Longline effort is number of sets; bottom trawl effort is number of tows; and setnet effort is number of sets. Dashed line denotes program not operating.

Fishing year	Bottom longline[a]				Bottom trawl[b]				Setnet[b]					
	North Island		WCSI		ECSI		WCSI		ECSI		SCSI		WCSI	
	V	*E*	*V*	*E*	*V*	*E*	*V*	*E*	*V*	*E*	*V*	*E*	*V*	*E*
1994–1995	1	16	1	50	—	—	—	—	2	17	—	—	—	—
1995–1996	10	157	2	124	—	—	—	—	10	231	5	111	2	11
1996–1997	19	706	2	103	—	—	—	—	6	165	3	36	3	28
1997–1998	10	591	1	73	—	—	—	—	—	—	—	—	—	—
1998–1999	16	422	5	79	—	—	—	—	11	273	2	21	—	—
1999–2000	18	342	2	67	1	1	—	—	12	305	2	32	—	—
2000–2001	15	259	4	19	5	287	23	1,764	11	409	3	59	5	67
2001–2002	13	160	6	47	13	478	22	1,388	16	301	2	63	15	277
2002–2003	11	133	7	45	22	396	17	1,850	11	247	1	49	9	350
2003–2004	10	183	5	137	17	667	15	1,274	9	176	2	37	10	255
2004–2005	12	113	5	114	24	1,181	16	2,164	10	155	1	29	8	330
2005–2006	4	58	8	205	11	473	14	1,780	7	152	1	40	5	212
2006–2007	1	21	4	80	8	394	10	2,100	3	51	1	16	3	43

[a] Bottom longline fishery for bluenose.
[b] Mixed-species fishery.

programs can run indefinitely on the goodwill of the participants. Even in the case of the rock lobster fisher-collected sampling programs, where there is a clear link between the sampling activity and the subsequent incorporation of the data into the stock assessment, the fishermen are reluctant to become involved. Table 5 documents how most of the vessels that initially enrolled in the programs in CRA 2 and 8 dropped away within a few years. On the other hand, CRA 5 has managed to maintain a reasonably consistent level of participation and has increased the amount of reported effort. Several of the key CRA areas have chosen to retain observers as their chief method to collect these data (CRA 3, 4, and 7; Table 2). The supervisors of CRA 8, on the other hand, have opted to pay their logbook participants, reasoning that the cost will be less while maintaining a high standard of information. While this change in policy is not readily apparent from the information in Table 5, I am told that the number of participating vessels would have otherwise dropped to unacceptable levels.

A frequent criticism made of fisher-collected sampling programs is that they can be biased. This is an important and valid criticism that must be addressed. Starr and Vignaux (1997) directly tested this issue, finding in this instance no evidence of bias. However, this is one of very few known direct comparisons of these types of fishery sample data. The program for the hoki offshore bottom trawl fishery along the east coast

TABLE 5.—Number of vessels, total effort (pot lifts), and number of rock lobsters measured by fishing year (1 April–31 March) for the three New Zealand rock lobster quota management areas (CRA 2, 5, and 8) that depend on fisher-collected sampling programs, as listed in Table 2. Dashed line denotes program not operating.

Fishing year	CRA 2			CRA 5			CRA 8		
	Vessels	Effort	Lengths	Vessels	Effort	Lengths	Vessels	Effort	Lengths
1993–1994	25	7,071	18,095	—	—	—	42	5,264	37,259
1994–1995	30	6,245	18,134	14	3,626	15,509	54	5,987	32,330
1995–1996	26	3,934	11,658	8	1,884	8,972	66	9,125	44,208
1996–1997	21	3,492	12,522	12	2,339	14,086	51	6,847	28,450
1997–1998	19	2,953	9,225	11	1,725	11,029	42	6,578	21,421
1998–1999	21	3,051	9,172	9	1,059	8,372	36	5,487	21,779
1999–2000	20	3,684	10,324	11	2,110	12,724	19	2,670	11,468
2000–2001	16	3,787	9,186	22	3,817	26,029	24	4,176	21,041
2001–2002	13	2,910	5,893	25	4,299	30,137	19	2,782	12,362
2002–2003	18	5,014	8,269	24	4,897	36,091	15	3,105	17,734
2003–2004	13	3,810	7,445	20	3,842	31,444	17	2,425	17,077
2004–2005	14	4,677	8,533	21	3,502	28,512	15	2,450	15,757
2005–2006	17	5,829	10,631	17	3,969	32,744	16	2,385	17,126
2006–2007	16	4,162	8,805	20	4,241	34,157	18	2,784	22,372
2007–2008	13	3,945	8,617	19	4,355	34,564	16	2,212	21,053

of South Island (Table 1) was discontinued in 2005–2006 because an unpublished comparison of hoki length frequencies obtained from this program with equivalent Ministry of Fisheries observer data showed that the fisher-collected data were probably biased, as evidenced by the lack of small fish in the fisher-collected length frequencies. This outcome is the result of using the fisher-driven sampling program to also manage the fishery, using the proportion of fish below a specified size to determine whether an operator would "move on" if that proportion was below a specified threshold. In this situation, there was an incentive for the operator to influence the data that were being collected. The principle is clear: linking voluntary discretionary sampling programs to enforcement is not a wise choice, as it will certainly result in the potential for bias in the collected data.

There is also potential for fishers to deliberately bias the data in order to influence the outcome of TACC decisions. While acknowledging this possibility, such activity seems unlikely for two reasons. The first is that the contribution to the data pool from each participant is relatively small, reducing the potential for bias from any single operator and requiring collusion among a number of fishers to significantly shift the resulting length or age distributions. The second reason is that it is not obvious how to bias such data because an excess of either large or small (or old and young) fish can be interpreted in a number of ways, some of which will be favorable for an increased TACC while others will be unfavorable. The potential for concerted effort by fishers who have a sophisticated understanding of population dynamics seems unlikely.

Conclusions

The New Zealand experience with fisher-collected sampling information has shown two things clearly: (1) this type of program can collect high-quality data that can be used in a quantitative fisheries stock assessment or to make fisheries management decisions and (2) collecting these data is a serious undertaking that requires careful design and constant monitoring and supervision. If these latter conditions are not met, the sampling programs will fail.

These stipulations are not really any different than would be expected from any normally operated research program obtaining similar types of data. The primary difference is that fisher-collected data involve a much larger group of people who tend to be untrained and who often do not fully understand the objectives of the program.

Fisher-collected sampling data have the potential to be excellent fishery data, given the dynamic nature of the design and the opportunity in many fisheries to obtain samples that can be drawn randomly. Data of this quality are worthy of pursuit, but they come at a cost; the supervision and other potential problems are not to be underestimated.

Finally, there is an aspect of this type of data that should not be underestimated. Involving fishermen in the collection of data that are used to manage their fisheries has important implications, particularly the implicit "buy-in" that necessarily comes when the data are collected by the stakeholders themselves. Even more importantly, the direct involvement of fishers in the science of their fishery means that they will take ownership not only of the data but also the analyses that stem from the data.

Acknowledgments

I thank Jim Prescott (at the time affiliated with South Australian Research and Development Institute), who initially proposed fisher logs based on designated pots to Paul Breen (National Institute of Water and Atmospheric Research), who in turn collaborated with me to set up the initial design for the New Zealand rock lobster fisher-collected data program. I also thank Philippe Lallemand (New Zealand Seafood Industry Council), who provided the maps and, along with Nokome Bentley (Trophia), provided me with up-to-date files from which to construct the tables in this report. I thank Kevin Stokes and Daryl Sykes for comments on a draft of this article. Finally, I thank the many fishermen who sampled and measured fish and lobsters so faithfully over all these years.

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