Marine: potting for lobster populations

Version 1.0

This specification was prepared by Debbie Freeman in 2017.

Contents

Inventory and monitoring toolbox: marine

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Te Papa Atawhai

Synopsis

Spiny lobsters (family Palinuridae) are conspicuous and important components of rocky reef communities worldwide. In New Zealand, four species occur, with the red rock lobster (sometimes referred to as spiny lobster), *Jasus edwardsii*, being the most common, found from the Three Kings Islands in the north, to the subantarctic Auckland Islands (Booth & Webber 2001). The packhorse or green rock lobster, *Sagmariasus verreauxi,* is also locally common in northern New Zealand. Both of these species also occur in Australian waters and support important fisheries there (Linnane et al. 2006a,b; Haddon & Gardner 2007). The other two lobster species that occur in New Zealand waters are the deepwater lobster *Projasus parkeri* and the tropical species *Panulirus versicolor*. True lobsters, such as the American lobster *Homarus americanus*, are similarly important from both ecological and fisheries perspectives but are not known to occur in New Zealand waters (although several attempts were made to introduce European lobsters to New Zealand in the 1800s and early 1900s; Thomson 1922).

Lobster potting is a method for harvesting these commercially, recreationally and culturally important species. Baited pots are set overnight (or over several nights) and attract lobsters into the pot, where they remain trapped (depending on their size) as a result of the design of the pots. This method is not only effective for catching lobsters for fisheries purposes, but also provides an opportunity to gather data on the relative abundance and population structure of these species. It is unlikely that potting would be used to estimate absolute abundance, unless it is for stock assessment purposes (which is not covered in this document).

Research potting for lobsters routinely occurs for the purposes of fisheries stock assessment. Lobster potting has also been undertaken for other research objectives, including for assessing the effectiveness of protected areas (e.g. Goni et al. 2006), tag-recapture analysis (e.g. Dunnington et al. 2005) and for assessing aspects such as lobster fecundity and recruitment (e.g. Tremblay & Lanteigne 2005; Tremblay et al. 2009).

While lobster potting provides a good method for assessing lobster abundance and population dynamics, a number of issues need to be addressed, either during the survey design or as part of the data analysis phase, for this method to be successfully used for inventory and monitoring purposes.

Glossary

Area of attraction — The seabed area within which lobsters are attracted to a baited pot. This is effectively your sample area, which is always unknown, and will vary according to aspects such as seabed structure, currents, water temperature and bait volume and type.

Catchability — Catchability is the proportion of fish in the stock that are caught by a defined unit of fishing effort.

Catch per unit effort (CPUE) The quantity of fish caught with one standard unit of fishing effort. For lobster pots, this can be presented in several different ways; for instance, as the wet weight of lobsters per pot lift or the number of legal lobsters per pot lift.

Pot saturation Gear saturation (in this case pot saturation) occurs when the probability of capture of more individuals is decreased by the number of individuals already captured. This will almost certainly exist, will likely vary with sex and season, and will lead to under-estimated relative abundance at high abundance.

Assumptions

- Sites are representative of the environment, gradient or effect (contamination level) that is being assessed.
- Sampling effort is similar across sites, locations and/or sampling occasions.
- The number of samples collected is appropriate to capture natural variability.
- Each pot independently samples the lobster population.
- Oceanographic and benthic environmental conditions are similar at each site, or considered in survey design and data analysis and interpretation.
- Behaviour of the target species is not affected by the protection or management status of sites intended to be surveyed, i.e. catchability is unaffected by management regime.
- CPUE provides a relative estimate of lobster density in the area surveyed.

Advantages

- Equipment is readily available, as it is usually exactly the same as used by the commercial and recreational fishery.
- Surveys are able to be undertaken more quickly, in a broader range of sea conditions and at deeper depths than some other methodologies (such as diver transects), including low or no visibility conditions, areas with strong currents or surge, and areas where there may be hazardous marine life.
- This method provides an opportunity for collaboration with recreational and commercial fishers and for members of the community to observe marine monitoring in action.
- Data are collected from a wide range of sites in the New Zealand inshore environment using this methodology, so data from particular sites can be placed in a wider context.
- This method targets the species of interest and has minor ecological impacts on the environment, usually with no or limited bycatch.
- There is a low level of incidental mortality of the target species.
- The equipment is not required to be tended while in the water.
- This method allows collection of abundance and population data (e.g. size distribution data, sex ratios, reproductive state, disease prevalence).

Disadvantages

- This method requires access to a vessel and fishing equipment.
- While not necessarily a disadvantage, selectivity and vulnerability may need to be considered when assessing population structure and abundance.
- Factors such as sea conditions, season, lunar phase and type of bait can affect the catch.
- Surveys may result in a low level of injury and/or mortality to the individuals surveyed (including through in-pot predation), and there may be minor bycatch issues.
- Bait is required to attract lobsters to the pots and is able to be consumed by the lobsters; bait therefore supplements the natural biological community.
- Depending on the site, there may be issues around perception of 'fishing' at the site that may need to be managed, in particular if the site is subject to fishing restrictions. One option is to ensure your vessel has a 'research' sign.

Suitability for inventory

- Baited pots are the most widespread method used globally to catch spiny lobsters commercially (Booth 2011).
- This method targets the species of interest and therefore is not suitable for broader inventory purposes.
- If issues such as catchability are taken into consideration during survey design, data analysis or interpretation, this method provides robust data on the relative abundance and population structure of lobsters at the survey site.

Suitability for monitoring

- This method is suited for the monitoring of lobster populations. Changes in abundance and population structure can be strongly associated with management actions.
- Data from monitored sites can be placed in the wider context through comparison with data collected by fishing vessels, if the survey is designed appropriately, and through research surveys across New Zealand's waters.
- Issues relating to catchability and pot saturation may need to be considered at some sites, in particular if the lobster population is anticipated to change significantly over time.

Skills

The following skills are required for designing the survey:

- Survey design skills for determining the number of replicates, stratification (if any) and placement of replicates, and what variables are to be recorded

- Knowledge of the factors that influence lobster catches and vessel operation that may need to be factored into the survey design
- Knowledge of the ecology of the species at the survey site, including seasonal migratory behaviour
- Statistical skills discussed in the design section

The lobster potting field methodology is virtually identical to a commercial lobster fishing operation using pots; therefore, similar skills and expertise are required. These include:

- Experience, expertise and appropriate qualifications in operating vessels and/or in working on vessels, in particular around heavy, mobile equipment
- A good level of fitness for working on a moving platform and for working with heavy, mobile equipment
- Experience and expertise in handling the pots and associated equipment, including procedures for baiting and clearing pots
- Experience and expertise in operating GPS equipment and depth sounders
- Experience and expertise in handling live lobsters and fish and minimising the effects of handling
- Knowledge of lobster biology, including how to measure them accurately and how to assess sex and maturity
- Ability to record data accurately in the field
- Ability to recognise and manage potential health and safety issues associated with this survey method

Resources

Survey work requires a minimum of three people to:

1. Skipper the vessel
2. Run the potting equipment
3. Sample lobsters and record the data

The following field equipment **will** be required (see also 'Full details of technique and best practice'):

- Appropriately equipped vessel (including davit, winch, required safety equipment, deck hose, GPS and sounder)
- Backup GPS
- Lobster pots, rope and surface floats
- Gaff or similar for retrieving pots
- Marker pen for re-marking abraded surface floats (a cattle ear-tag marker pen, available from agricultural supply stores, will work well on soft buoys)

- Bait
- Clean, empty fish bins (with lids) for lobsters
- Small tarpaulin or similar to provide shade for lobsters that are out of the water
- At least 2 pairs of vernier callipers (see below), plus lubricant (preferably foodsafe); callipers will need to measure up to 250 mm
- Waterproof data sheets, pencils and clipboards
- Personal protective equipment, including gumboots and gloves for handling live lobsters, life jackets, waterproof jacket and pants, adequate sun protection (including sunscreen, hat, sunglasses) and/or warm clothing
- Gaff and/or thick gloves for retrieving any hazardous marine life that is caught incidentally

In relation to callipers, note that it can be very difficult to position ordinary vernier callipers on the tips of the spines of a lobster at sea. Modifications may be made to callipers to assist with this, but particular care needs to be taken if any adjustment factors are required. Also note that metal callipers can be very sharp at the tips and may present a safety hazard.

The following field equipment **may** be required:

- Handheld field computer or tablet (if entering data directly)
- Long ruler or large callipers for measuring packhorse lobsters (in northern regions)
- If tags are being deployed (not covered by this document):
    - Lobster tags
    - Tagging gun (at least 2) and tag needles (at least 2)
    - Ethanol for sterilising tag needle
    - Small toothbrush for scrubbing tag needle
    - Scissors (if lobsters are to be pleopod-clipped)

An equipment checklist in included in Appendix A.

Approvals required

Prior to embarking on such a survey, you should liaise with DOC and Fisheries New Zealand to seek advice on whānau, hapū and iwi consultation requirements and/or any Treaty settlement requirements.

Using this method for inventorying or monitoring lobsters will require:

- A Special Permit issued by Fisheries New Zealand under the Fisheries Act
- Approval by an Animal Ethics Committee (unless lobsters are to be retained)

Depending on the area to be surveyed, this method may require other permits, including under the Marine Reserves Act and/or Fisheries Act.

Minimum attributes

Consistent measurement and recording of these attributes is critical for the implementation of the method. Other attributes may be optional depending on your objective. For more information refer to 'Full details of technique and best practice'.

DOC staff should also complete a 'Standard inventory and monitoring project plan' (docdm-146272).[1]

The minimum attributes will depend entirely on the purpose of the survey. However, it is likely that the attributes listed in Table 1 will be the absolute minimum that need to be recorded during a lobster survey using a potting technique. A full list of attributes that should be considered (and that are part of a standard data entry form) are provided in Table 6 in 'Full details of technique and best practice'.

Table 1. Minimum attributes to be recorded during a lobster survey using the potting technique. Please refer to the data entry section for further details of each attribute, plus details of additional attributes that should be recorded.

Attribute	Description
Organisation	Name of the organisation responsible for collecting the data
Date	Date of pot lift
Lunar phase	Lunar phase
Sea conditions	Description of sea conditions
Vessel name	Name of vessel that lifted the pot
Survey lead	Name of survey lead (or skipper)
GPS position	GPS position of pot lifted
Pot number	Unique identifier for the pot
Pot depth	Depth of water in which pot is in
Pot type	Type of lobster pot
Pot size	Volume of pot in m^3
Bait type	Type of bait used
Soak time	Length of time pot(s) deployed (hr)
Species	Lobster species
Lobster sex	Sex of lobster
Lobster tail width	Tail width of lobster (mm), preferably to the nearest 0.1 mm
Pot mortality	Number of target species not alive per pot
Pot bycatch	Identity of any bycatch species per pot

Data storage

Given the mobile, remote and wet environment associated with using this survey and monitoring technique, data security is particularly important. While direct entry of data using a handheld field

[1] http://www.doc.govt.nz/Documents/science-and-technical/inventory-monitoring/im-toolbox-standard-inventory-and-monitoring-project-plan.doc

computer, laptop or tablet may be possible in some conditions, attention will need to be paid to the effects of seawater, sun glare and handling on the equipment. Power requirements will also need to be considered, particularly given the wet environment and particular voltage available on some vessels.

Where field data sheets are used, these should be pre-printed with the required data fields to be completed (see Appendix A) to ensure that all the data required for comprehensive and robust analysis of the survey are collected.

On return from the field, data sheets should be rinsed in freshwater to remove any salt (being careful not to erase any data through abrasion of salt crystals), air-dried and then scanned or photographed to provide a digital copy of each data sheet. Both the digital and hard copies of the field sheets should be stored securely and as described in 'Full details of technique and best practice' (see 'On return from the field' on page 34).

DOC is currently developing a national database to hold and provide access to data collected from marine reserve monitoring in New Zealand. The aims of the database are to:

- Support consistent standards in national marine reserve monitoring programmes for marine environmental quality
- Coordinate and optimise marine reserve monitoring in New Zealand
- Provide a high-quality monitoring dataset for New Zealand's marine reserves

Once operational, this methodology will be updated with a description of how to lodge data within the national database. In the interim, data should be recorded within the spreadsheets associated with this methodology. It is essential that all raw data sheets are completed, digitised and backed up on external hard drives. Raw data and associated metadata should be entered into databases/spreadsheets in a standardised format. This should include metadata stored in a separate sheet, and a sheet containing sampling data collected during the monitoring programme stored in one 'brick' of data that can be continually updated as more surveys in that monitoring programme are carried out.

For internal DOC monitoring, information pertaining to each survey within a marine reserve and resultant data/reports should be entered into the Marine Protected Area Monitoring and Research (MPAMAR) datasheet ('MPAMAR metadata—national'—doccm-1163829)[2] so there is an easily accessible account of the survey.

Analysis, interpretation and reporting

Seek statistical advice from a statistician or suitably experienced person prior to undertaking any analysis. It is essential that statistical advice is sought prior to any data collection to ensure that the design of the data collection is robust and suitable for answering the question at hand. For quality

[2] http://www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/im-toolbox-marine-MPAMAR-metadata-national.xls

control, the data should be checked for unlikely abundances or sizes of organisms, and errors in data entry. Further information on analysis, interpretation and reporting can be found in 'Full details of technique and best practice'.

Data metrics

There are a number of data metrics that can be derived from lobster potting data that will provide the ability to assess the distribution and abundance of lobsters within your survey area (Table 2). The calculation of some of these metrics is reliant on having recorded data on both lobster size and sex.

Table 2. Examples of data metrics that can be calculated from lobster potting surveys.

Metric	Required data	Calculation
Catch per unit effort (CPUE)	• Individual lobster size (tail width and/or carapace length) • Lobster sex • Minimum legal size	CPUE can be calculated in various ways, but is usually presented as kilograms (wet weight) of legal-sized lobsters per pot lift. CPUE can also be presented as total wet weight (both legal and sublegals), or number of lobsters per pot (total number, or split into legals and sublegals).
Sex ratio	• Number of males and females in each pot	Sex ratio is usually presented simply as the mean percentage of males per pot; or as a percentage of the total catch.
Size structure	• Lobster size • Lobster sex	Population size structure may be presented simply as mean tail width, or the full set of data may be presented as size frequency histograms (for each sex). The latter is usually more informative as it may provide information on aspects such as growth rates and recruitment.

Factors to take into account during analysis and interpretation

A relatively large range of factors can influence lobster catches using the potting methodology and should be taken into consideration during both the design phase and during the data analysis and interpretation phase (and therefore these factors should be recorded as part of the survey).

One of the main metrics derived from lobster potting, CPUE, is particularly susceptible to influence from a range of environmental and biological factors. It is assumed that CPUE is proportional to the abundance of lobsters at that site (Booth 2011). However, the assumption that CPUE is proportional to density only holds true if the probability of capture of every member of the population remains constant (Morgan, 1974). Lobster catchability varies according to a range of factors, including bait type, lobster moult cycle, environmental influences (such as lunar phase and season), pot-shyness, competition around the pot, pot saturation and pot escapes (Booth 2011). Such issues can be addressed through standardisation of methods and equipment (e.g. pot size), but knowledge of the influence of each of these factors on catchability is often limited (Booth 2011).

Table 4 (on page 24) provides a list of some of these factors and summarises how they may affect catches.

It is important to understand catchability and the factors that influence it, as it will likely explain much of the variability in your survey results. For example, larger lobsters generally have higher selectivity (Ziegler et al. 2002) such that you are more likely to catch these larger individuals than you would expect from their abundance relative to smaller lobsters. Changes in the catchability of lobsters can therefore affect our ability to compare populations with significantly different size and sex compositions; for example, fished and unfished populations (MacDiarmid, 1994; Frusher et al. 2003; Goni et al. 2003).

Interpretation

Interpretation of results should be performed with the assistance of a statistician as well as consideration of the major driving forces operating within the system. At this stage, it should be determined whether the objectives of the original data collection have been achieved and whether the data is sufficient to answer those questions outlined prior to the initial surveys.

Reporting

Reporting will largely be governed by the purpose of the survey, duration of the monitoring and data collection. If data collection is ongoing, regular reports should be submitted at 3–5-year intervals, whereas for short-term (< 2 years in duration) data collection, reports should be submitted within a year of the final data collection. The way in which you choose to report your survey results will depend largely on your survey objectives. However, the following are examples of ways in which you can present your data to demonstrate different aspects of lobster ecology.

Catch per unit effort

Spatial and temporal changes in CPUE can usefully be displayed using a geographic information system (GIS), particularly where you have good spatial coverage of your survey area. Refer to the 'Data analysis' section for further details about CPUE.

Figure 1 provides an example of how this can be done and demonstrates how this allows you to quickly visualise changes in distribution and abundance over time. Figures 2 and 3 provide additional examples of how CPUE data can be presented to highlight particular factors that may be influencing catches, such as management regime and season.

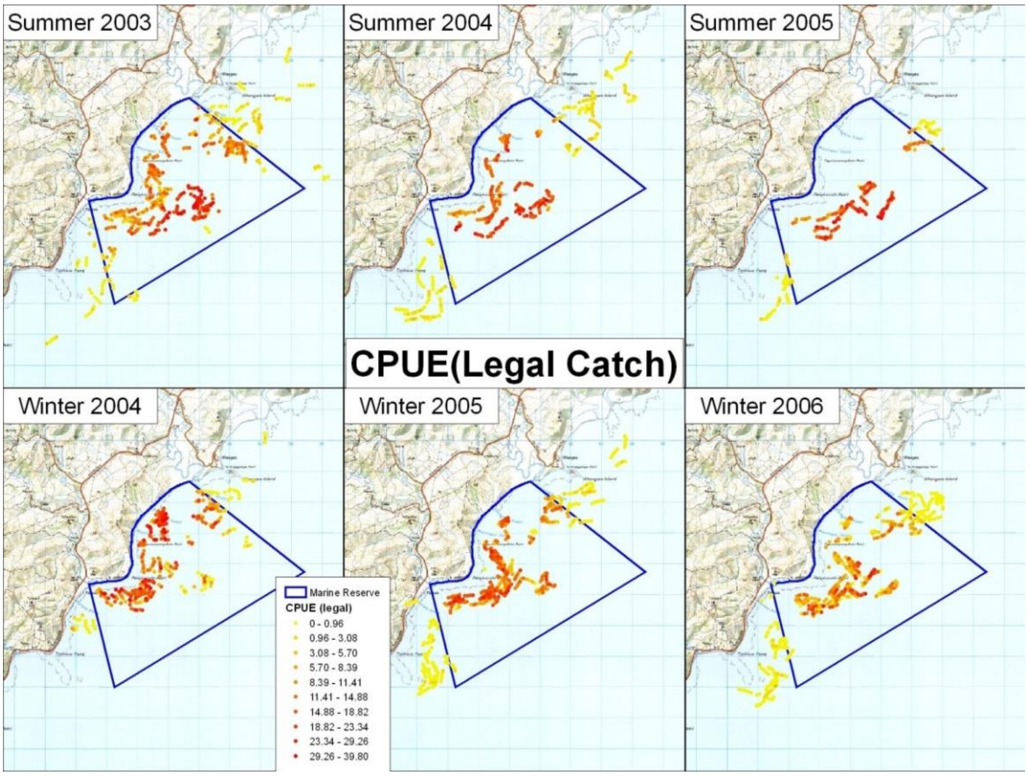


Figure 1. Maps developed using GIS, showing spatial changes in CPUE (kg per pot lift of legal-sized lobsters) among six consecutive surveys of Te Tapuwae o Rongokako Marine Reserve (blue boundary) and adjacent reefs.

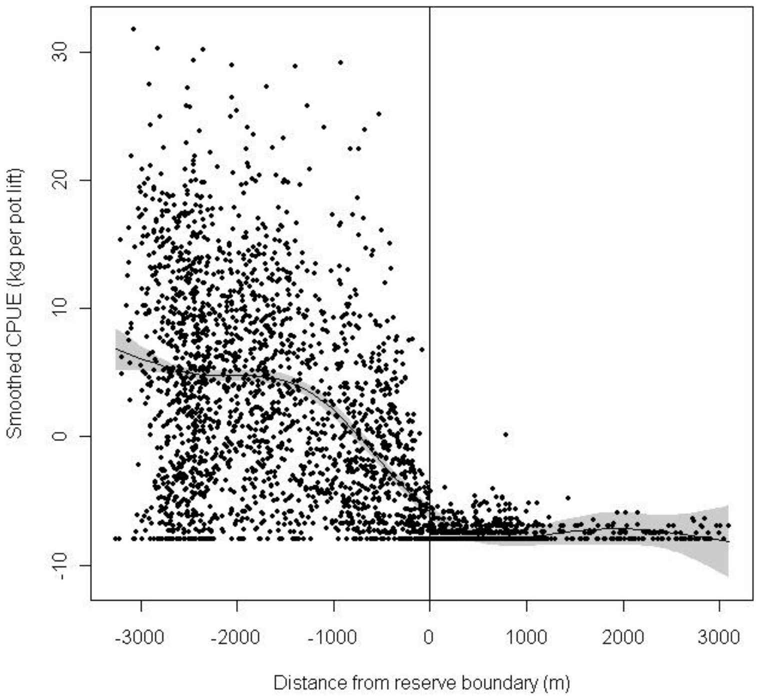


Figure 2. Plot of CPUE as a function of distance from the boundary of a marine reserve (Freeman unpubl.).

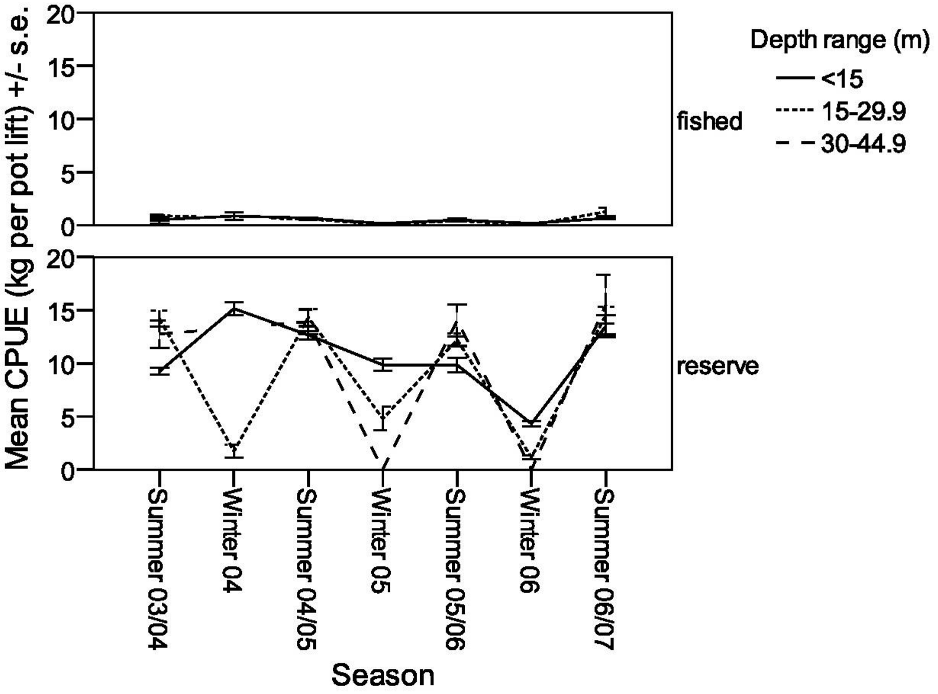


Figure 3. CPUE data presented graphically so that seasonal changes in depth distribution of lobsters can be easily discerned (Freeman unpubl.).

Case study A

Case study A: habitat patches that cross marine reserve boundaries: consequences for the lobster *Jasus edwardsii*

Synopsis

The purpose of this study was to compare abundance of lobsters inside and outside a marine reserve and to describe the movement patterns inside and outside the marine reserve, including across the reserve's boundary. It was undertaken in and around Te Tapuwae o Rongokako Marine Reserve on the east coast of the North Island. Using tag-recapture and potting data, the study showed that boundary placement was important for understanding the patterns in abundance of lobsters (including in protected areas). Lobsters on reefs fully encompassed by the marine reserve were significantly more abundant and larger than on reefs where a small proportion was within the reserve's boundary.

Objectives

The objective of this study was to determine how the spatial relationship between habitat patches and reserve boundaries affected lobsters within and adjacent to Te Tapuwae o Rongokako Marine Reserve.

Sampling design and methods

Initial advice on the wider study of which this case study was a component was sought from an expert in the field of lobster ecology and fisheries (Booth 2003). This advice highlighted some of the key knowledge gaps to be addressed and some of the considerations around survey design and logistics.

In order to determine the abundance and size structure of lobsters within and outside the marine reserve, lobster potting was undertaken on a seasonal basis (approximately every 3 months) over a period of 3 years. During each survey within the marine reserve, between 134 and 294 pot lifts were completed. Between 15 and 134 pot lifts were completed during each survey outside the marine reserve. A total of 3168 pots were sampled, with each having a 24-hour soak time (overnight). Additional data (tag recaptures) from commercial fishers were used for analysis of movement patterns, but not abundance.

Pots used during research surveys aboard commercial fishing vessels were mostly standard 52 mm mesh pots or hurricane reinforced concrete (HRC) pots used widely in the commercial lobster fishery (Figure 4), but some smaller pots were also used as they were easier to handle on the vessel used for that particular survey.

Figure 4. Standard HRC (hurricane reinforced concrete) lobster pot used widely in the New Zealand lobster fishery, and used during the research surveys for this case study.

The location and number of pots set were influenced by aspects such as sea conditions, the particular vessel being used and whether there was other fishing gear in the water, but the intention was to sample a wide depth range of reef habitats throughout the marine reserve and within about 3 km of the reserve's boundaries, attempting to place each pot at least 100 metres from an adjacent pot to avoid pot competition. The distribution and extent of reef habitat had previously been identified through a sidescan sonar survey.

Data recording

Data were recorded using a handheld Allegro field computer with custom-designed software (DOCTAG). The data fields that were recorded using this device are provided in Table 3.

Table 3. Data fields recorded using a handheld computer for this lobster potting case study.

Field	Description
WINDDRY	Wind direction yesterday
WINDSPY	Wind speed yesterday
WINDBEY	Wind Beaufort scale yesterday
WINDDRT	Wind direction today
WINDSPT	Wind speed today
WINDBET	Wind Beaufort scale today
SWELLDY	Swell direction yesterday
SWELLHY	Swell height yesterday
SWELLCY	Sea state yesterday
SWELLDT	Swell direction today
SWELLHT	Swell height today
SWELLCT	Sea state today
RECORDER	Name of person recording the data
SAMPLERN	Name of person sampling
LOCATION	Name of sample location
VESSEL	Name of vessel
LOBSID	Sequential number of lobster in each pot
POTNUM	Number of pot
LOBTIME	Time lobster was recorded
SPECIES	Species of lobster
LOBSEX	Sex of lobster
CARAPA	Carapace length
ODINJU	Number of old injuries (missing limbs that had sealed)
NWINJU	Number of new injuries (missing limbs that had not sealed)
DISEAS	Scale of tail fan necrosis
TAGONE	Tag number
TAILWIDTH	Tail width
RECAP	Is lobster a recapture?
COMMENT	Space for additional notes (e.g. bycatch)

GPS positions and information such as soak time for each pot were recorded separately on field sheets.

Data analysis

For the purposes of this study all lobsters with a tail width less than 54 mm were excluded from the analysis. All depths were adjusted for tidal height (back calculated using pot set/haul time and tidal state at that time).

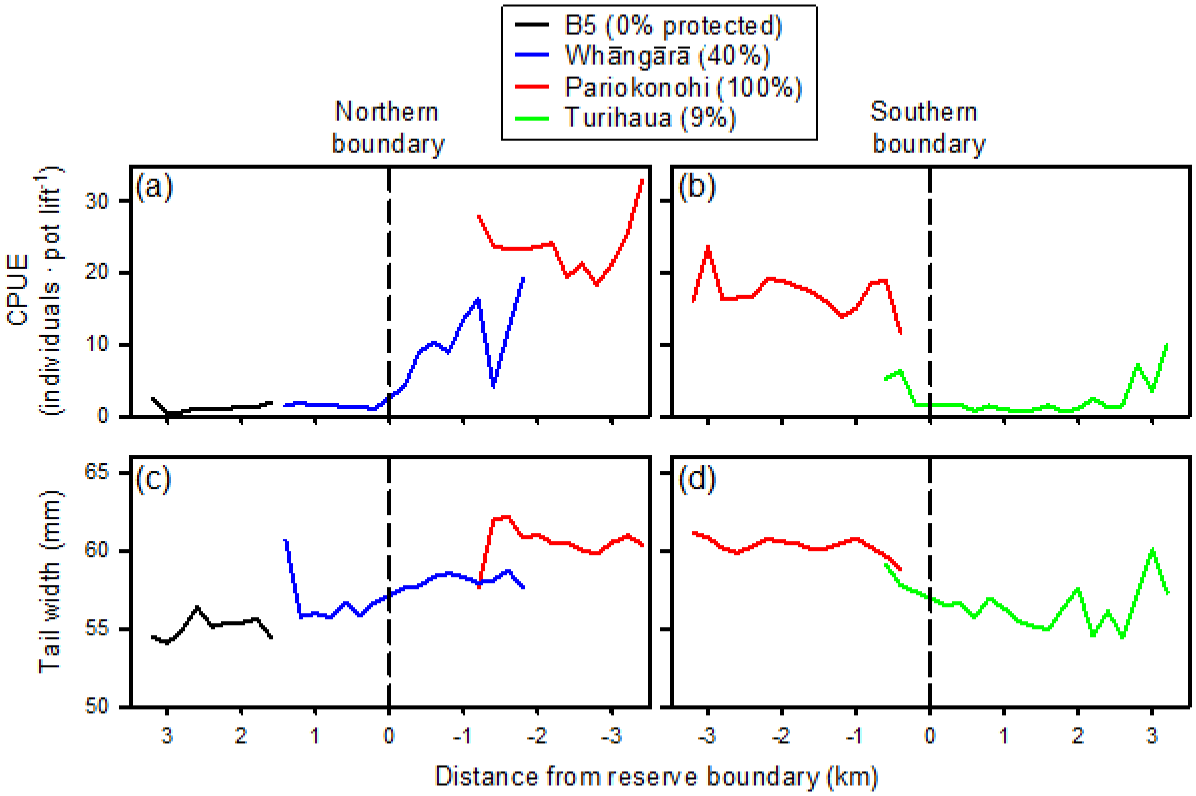
In this case, CPUE was calculated as the total number of lobsters per pot (for standard-sized pots only). Mean size of males per pot used data from both the standard-sized and smaller pots.

To assess seasonal changes in lobster abundance, the depth at which the maximum CPUE occurred for each survey was calculated for three size classes of males and two size classes of females. Data were plotted graphically, providing the ability to clearly see if seasonal inshore–offshore migrations were taking place, and whether there were any differences between the sexes and whether lobster size was a factor in these movements.

Results

- 921 lobsters tagged in the reserve were recaptured.
- Some tagged lobsters moved more than 4 km from their initial release position but most movements were in the order of 1–2 km for males and 100–200 m for females.
- Clear seasonal depth-related patterns in abundance were evident.
- 98.5% of recorded movements took place within a reef; 1.5% involved movement between reefs (Figure 5).
- The rate of emigration from each reef within the reserve decreased steadily as the proportion of reef that was protected within the reserve increased.
- Average CPUE on the protected parts of the reefs were strongly positively correlated with the proportion of reef protected (Figure 6).
- Body size was positively correlated with the proportion of reef protected (Figure 6).

Average densities and average size of legal males were higher within the centre of the reserve.



- Figure 7).

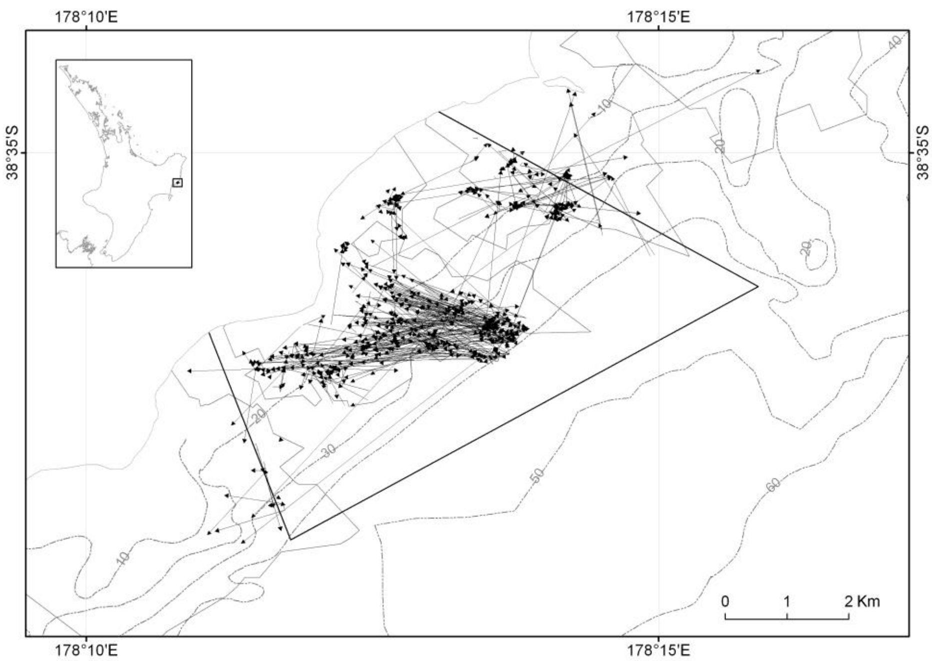


Figure 5. Map showing the movements of tagged male lobsters, recaptured during research surveys and by commercial fishers. Rocky reefs are shaded.

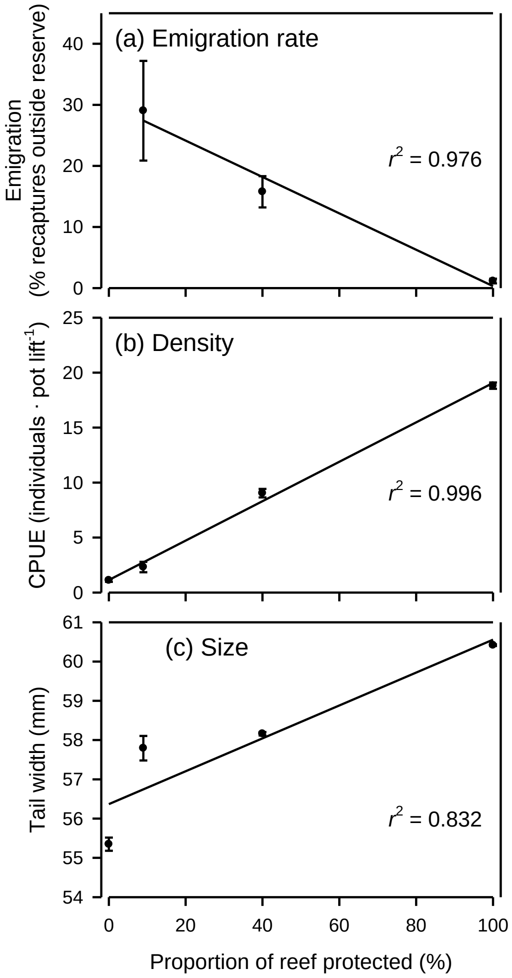


Figure 6. Relationships between the proportion of rocky reefs protected within Te Tapuwae o Rongokako Marine Reserve and (a) spiny lobster emigration rates, (b) CPUE (standard-sized pots only, all data pooled), and (c) sizes (standard-sized and three-quarter-sized 52 mm mesh pots combined) within the reserve. Emigration rate is the percentage of lobsters tagged on the protected portion of a given reef that were later recaptured outside the reserve (of all lobsters from that portion of reef that were recaptured). Data from four reefs are presented: 0% coverage, B5 Reef; 9%, Turihaua Reef; 40%, Whāngārā Reef; 100%, Pariokonohi Reef. Regressions are run on averages. Error bars: ±SE.

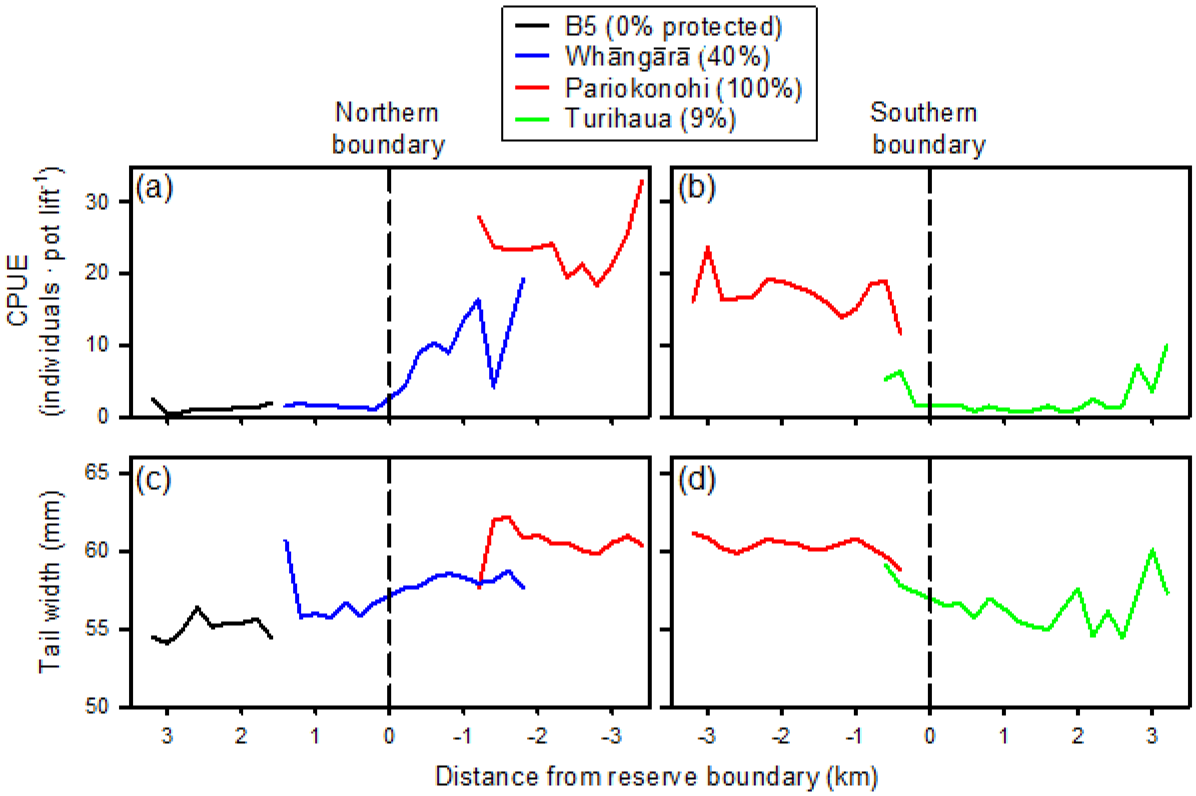


Figure 7. Average CPUE (number of legal-sized lobsters per pot, all standard-sized pots) and size of legal male spiny lobster (standard-sized and three-quarter-sized 52 mm mesh pots combined) as a function of distance (in 200 m increments) from the reserve boundary for each of four reefs in and adjacent to Te Tapuwae o Rongokako Marine Reserve.

Limitations and points to consider

Selectivity and vulnerability were thought to have influenced the results, particularly within the marine reserve where catches were often of large male lobsters. Comparisons of the potting data with diver survey data suggested that pots may have oversampled males (i.e. males were over-represented in the catches). This resulted in too few females being captured to allow statistical analysis.

Working with commercial fishermen was an important aspect of this study, enabling not only provision of their expertise and local knowledge, but also an opportunity for them to be involved in a research programme. Utilising standard equipment provided an opportunity to compare these results with those from catch sampling of fishing operations undertaken across the wider lobster fishery.

A range of bait types was used during this study, primarily as a result of changing seasonal availability across the long survey period. Ideally, the same bait type should have been used to avoid any potential effect of bait type on catches.

Low levels of lobster mortality, where lobsters were dead on hauling, were recorded during this study (Freeman 2008), which was particularly important given the marine reserve status of part of the survey area. Some bycatch was recorded—mostly octopus, but also carpet sharks (Figure 8), banded wrasse, hiwihiwi, scarlet wrasse, hagfish, blue cod, snapper, conger eel, scorpionfish, red moki, skate, sweep and triplefins. The vast majority of these were able to be released alive (Freeman unpubl.).

Uneaten and leftover bait was discarded well away from reef habitat to avoid unintended potential effects on lobster abundance and distribution.

Figure 8. Carpet sharks caught as bycatch during the potting survey; all were released alive and unharmed.

References for case study A

Booth, J.D. 2003: Research sampling design for rock lobsters in Te Tapuwae o Rongokako Marine Reserve. *DOC Science Internal Series 128*, Department of Conservation, Wellington, New Zealand.

Freeman, D.J. 2008: The ecology of spiny lobsters (*Jasus edwardsii*) on fished and unfished reefs. Unpublished PhD thesis, University of Auckland, New Zealand.

Freeman, D.J.; MacDiarmid, A.B.; Taylor, R.B. 2009: Habitat patches that cross marine reserve boundaries: consequences for the lobster *Jasus edwardsii*. *Marine Ecology Progress Series 388*: 159–167.

Full details of technique and best practice

The design of a lobster potting survey and its implementation will depend on the purpose of the survey and the hypotheses being tested. However, the basic methodology and the protocols for data recording, entry and storage should apply across surveys to ensure long-term consistency in data capture, data security and accessibility, and the ability to compare across studies.

Before you begin

Consider the following questions. By thinking about these issues before you begin to design your survey, you can help avoid potential issues with your survey, including logistical issues and later data analysis and interpretation issues, and maximise opportunities for collaboration.

- What is the objective of my survey? What questions am I trying to answer by undertaking this survey?
- Who should I talk to in terms of seeking support, involvement or permission to undertake this survey? Are any permits needed?
- Who can I ask for help with my survey design? Are there any local experts (including fishermen, researchers, management agency staff) who may be able to help? What other previous research or monitoring has been undertaken in this area that I can build on?
- Do I know enough about this species in the area I am interested in surveying? Where are the knowledge gaps?
- Who are the stakeholders who may be interested in this survey? How best do I engage with them and when?
- Who should I involve in the survey and why?
- Does my survey provide an opportunity for gathering other information about my species or area of interest?
- What might be the constraints around undertaking this survey? Are there any particular issues I need to consider in designing and undertaking this survey?

Field equipment

Vessels

While a range of vessels may be suitable for your survey, you should consider the following:

- How many pots will I need during my survey? How many pots will the vessel need to be able to carry at one time?
- Is the vessel certified for carrying passengers?
- Who is supplying the pots, rope, bait etc. for the survey?
- Are there any particular facilities or equipment you need to be on board during the survey, and is the skipper happy for these to be on their vessel?
- Are the GPS unit and sounder acceptable? What coordinate system is it set up to?

If you employ the use of a commercial lobster fishing vessel, then it is likely that the vessel will have everything you need for a successful survey, but make sure you check with the skipper well beforehand. You may need to supply additional equipment prior to the survey.

Lobster pots

A range of lobster pot designs are available and there is variation around the world (and around New Zealand) in terms of what pots are used in the fishery (examples are shown in Figures 9–11). There are also aspects such as mesh size and escape gap provision that may vary.

Standard commercial pots will have escape gaps and selectivity of sublegal-sized lobsters is low, but if the data from your survey are intended to be comparable with data from the commercial fishery, then it is essential to use the same type of pots. It is also essential to record the type of pots used during your survey. Take photographs, and record aspects such as pot dimensions and size of any escape gaps and main entrance. You should not change the type of pots between or within surveys unless this is a part of your survey design.

In deciding what type of lobster pot (including mesh size) to use in your survey, you should consider:

- The component of the lobster population you are intending to sample—if you want to sample small lobsters (including sublegal-sized lobsters) you will need to use a smaller mesh size than is standard
- Your ability to safely handle the pots on the vessel you are intending to use (some designs are both large and heavy)
- The type of pots used in the wider fishery—using the same type will allow you to compare your survey results with those from around your survey area
- Any particularly sensitive habitats or species in your survey area
- The anticipated abundance of lobsters in your survey area—where population abundance is high, you may experience pot saturation when using smaller pots

Pots will need an adequate length of rope (consider aspects such as tidal height and current) and a named float (at least name and phone number). The float should also be numbered to be able to match your lobster data to each pot; your permit conditions may also require additional information to be written on the float. It is likely that you will need to provide new floats to replace those that the commercial fishing vessel uses during its normal fishing activities (if you are using a commercial vessel).

Figure 9. Standard HRC lobster pot used widely in the New Zealand commercial lobster fishery.

Figure 10. Standard HRC pot covered in fine mesh to allow capture of juvenile lobsters.

Figure 11. An example of a wooden pot commonly used in Australia.

Personal protective and other equipment

Working on a moving vessel at sea can present particular health and safety risks, including working around ropes, working in a wet, slippery and moving environment, and exposure to the elements. You should be prepared with the usual equipment you need when working on a vessel (e.g. sunscreen, hat, sunglasses, warm clothing, adequate food and water, life jacket, seasick medication). You will require adequate safety and emergency planning documentation. In addition, you must consider the following:

- **Wet weather gear:** Even though the weather may be warm, you will likely get wet when pots are brought on board the vessel, when the deck is hosed, and when handling live lobsters. Wet weather gear, particularly trousers, is useful for staying dry and also for protecting your clothing.
- **Gumboots:** If working from a commercial vessel, there is likely to be a deck hose. Gumboots will help keep your feet dry and warm, and will also provide protection from heavy equipment.
- **'Bum bag' or tool belt:** It is useful to be able to have somewhere to keep your callipers (and if tagging, equipment such as tags, tagging gun, tag needle cleaning gear etc.). Having a small bag or tool belt allows easy access to this equipment and keeps them from dropping and rolling around the deck.
- **Gloves:** For handling lobsters, you will need thick gloves—either thick cotton gloves, or PVC gloves. Lobsters have very sharp spines (particularly around their eyes and along their legs), and larger lobsters can also cause significant injury with their claws. You will need to wear gloves to protect your hands. If you are not familiar or comfortable with handling live lobsters, talk with the skipper and crew.
- **Emergency equipment:** Ensure that the vessel has adequate systems for shore communication, including VHF radio.

Survey design considerations

As noted previously, there are a number of factors that can influence lobster catches that should be considered during the design phase of your study. The particular details of your survey design will depend largely on what objectives you are endeavouring to achieve, but the following provides an overview of some of the factors that should be considered in using this lobster potting methodology.

Generally, the primary goal of undertaking lobster potting is to obtain data on the distribution, abundance and population structure of lobsters within your survey area. You may be comparing these parameters among different areas, among different management regimes, or using the method to assess management effectiveness. Lobster potting is also often used as a means simply to catch lobsters for other sampling, such as for tag-recapture (to obtain data on lobster movement and/or growth).

One of the main metrics derived from lobster potting is CPUE. As data such as kilograms of lobsters per pot lift are often the only figures available from commercial fisheries (Booth 2011), this can be particularly valuable for spatial comparisons across broad scales.

Useful CPUE data uses a design that addresses, as far as possible, the variability in any factors that are known to affect catch and catchability, such as pot competition (and current, which will influence area of attraction), soak time, seasonal changes in distribution associated with moulting and mating, bait type, lunar phase and sea conditions (e.g. Smith & Tremblay 2003). Table 4 lists some of the factors that may influence catches in your survey area and gives some suggestions for how to take these factors into account during the design or analytical stages of your survey.

Spatial arrangement of pots

Because pots are baited to attract lobsters to them, there is a risk of pot competition if they are set too close to one another. This can result in reduced CPUE as the sample population for each pot is effectively reduced. A number of studies have endeavoured to determine how far pots need to be apart to avoid this problem. A distance of at least 100 metres is considered to be sufficient in many cases (Jernakoff & Phillips 1988; Bell et al. 2001; Aedo & Arancibia, 2003).

In terms of the spatial arrangement of pots, possible options are:

4. Grid survey
5. Randomised design
6. Stratified random design

A grid survey would be appropriate if the objective of your survey is to undertake an inventory, or to describe the distributional patterns of lobsters at your site of interest. With this design, your survey area would be divided into a grid, with stations within the grid being sampled by replicate pots.

A randomised design is appropriate for measuring abundance and size frequency over time and allows inference about the whole population (unlike a fixed-grid survey).

A stratified random design would be appropriate if you are intending to make comparisons between sites with different management regimes (e.g. between fished and unfished areas) or where there are (for example) different proportions of habitat in your survey areas.

How pot locations are chosen is critical to any subsequent inference. Random locations must be truly random, with locations determined by a computer method—this may need consideration of an exclusion zone so that pots are not set too close to each other. You should not select pot locations haphazardly, or allow the skipper to select pot locations, as these may create bias in your data.

A pilot study will assist with determining your survey design and aspects such as levels of replication and soak time.

Table 4. List of the range of factors that may influence lobster pot catches and how this can be taken into account during either the design and/or analysis phases

Factor	How does this influence catches?	How can this factor be taken into account?
Bait type	Bait species and the condition of the bait (e.g. freshness) can influence the 'attractiveness' of the pot to lobsters.	Try to use only fresh bait and, if possible, use the same species of bait for the duration of your survey. Be sure to record bait type, and if you need to use different bait types, include this as a factor during your statistical analysis.
Lobster moulting and reproductive cycle	Lobsters have a complex moulting and reproductive cycle and do not feed (or reduce their intake of food) at certain points during this cycle (e.g. directly prior to and after moulting). This means they will be reluctant to enter baited pots at these times. Lobsters may also migrate into or out of your survey area at certain times of the year. These cycles can therefore affect abundance, size structure and sex ratio.	You may wish to conduct surveys at particular times of the year (e.g. when both sexes are located in shallower water) and maintain this timing for subsequent surveys. At the least, investigate the particular seasonality of lobsters in your survey area (e.g. talk with local fishers and/or researchers), record the timing of your survey and take this into account during design and analysis.
Lunar phase	Lobsters can be more or less 'catchable' at particular points in the lunar phase.	Record lunar phase (e.g. days after new moon) and take this into account during design and analysis (e.g. conduct each survey at a particular lunar phase).
Pot-shyness	Lobsters can become 'pot shy', where they avoid entering baited pots.	Pot shyness can be detected using tag-recapture analysis and/or overlapping pot surveys and observational studies (e.g. diver surveys or remote video monitoring of pots).
Soak time	While more lobsters may enter a baited pot the longer it remains in the water, this also presents an increased risk of predation (by conspecifics, octopuses or bycatch), escape and mortality, all of which will influence your survey results.	Try to keep soak time consistent throughout your surveys (e.g. overnight), but record this and if you do need to vary soak time, include it as a factor in your analysis. You may need to exclude longer soak times from your analysis.
Sea conditions	Conditions such as heavy swells can influence catches.	Plan your survey for a period where you are likely to get consistent conditions, but record them (e.g. swell height, wind strength) and take them into account during your analysis if need be.

Factor	**How does this influence catches?**	**How can this factor be taken into account?**
Pot saturation	Pots have a limited capacity, and in some cases they can reach a point where no more lobsters are able to enter a pot, potentially underestimating lobster abundance.	You will be unlikely to know if pot saturation is an issue unless you have diver or other observational data to go alongside your potting data. Consistently high catches may indicate that pot saturation is an issue. If you suspect pot saturation, additional surveys using alternative methods may be required, depending on your survey objectives. Using remote cameras on the pots can also be insightful. Undertake surveys at the same time of year to avoid effects of moulting on pot saturation.
Pot escapes	Some pots may be designed to allow smaller lobsters to escape from baited pots, but lobsters can also escape through the entrance when a pot is nearing capacity. This will reduce pot CPUE and may also influence size structure.	If you are using pots with escape gaps, you will need to factor this in to your analysis as your population comprises only those lobsters that are vulnerable to capture. Where abundance and/or biomass is high, you may need to consider pot escapes during your analysis and interpretation. Watch pots as they are lifted to the surface to see if lobsters are escaping through the entry. Using remote cameras on the pots can also be insightful. Use estimates of selectivity if required.
Pot competition	Lobsters are highly social animals and will compete for bait. This includes ‘pot guarding’ behaviour and fighting over bait. Such behaviour will reduce catches; for example, if lobsters are prevented from entering a pot. In some cases (e.g. if a large lobster guards the entrance to a pot), an empty pot may result. Additionally, if pots are located too close together, they will compete for the same lobsters, thereby reducing CPUE in those pots.	Try using remote cameras to see if bait guarding is an issue. If it is, you may need to use alternative survey methods. To avoid competition between pots, place pots at least 100 metres apart (Aedo & Arancibia 2003).
Bycatch	Octopuses can be responsible for injury or mortality of lobsters in pots; their presence near a pot may also prevent lobsters from entering a pot, thereby reducing CPUE. Bycatch of some species, particularly large or highly mobile species (such as conger eels or carpet sharks) may result in reduced lobster CPUE depending on when the bycatch occurred.	Record all instances of lobster mortality, and presence of any bycatch. Include this as a factor in your analysis. You may need to exclude from your analysis any pots where octopus predation was an issue.

Factor	How does this influence catches?	How can this factor be taken into account?
Management regime	Depending on the regime, lobster abundance and/or size structure may be affected; for example, marine reserve status may enhance lobster biomass. Note that this in turn may affect aspects such as pot saturation, and the effects of catchability may differ among management regimes. For example, Buxton et al. (2006) found that estimates of lobster abundance derived from pot surveys were more conservative than diver surveys for lobsters within Maria Island Marine Reserve.	This should be taken into account during the survey design phase and also as part of the analysis and interpretation.

Ecological effects of lobster potting

Booth (2011) provides an overview of the potential bycatch issues with lobster potting. He notes that while escape gaps in standard pots assist with reducing bycatch, and most animals bycaught in pots can be returned alive, there have in some instances been bycatch issues of concern. Before lobster potting surveys are undertaken, it is recommended that the following be considered:

- Discuss possible bycatch issues with local fishers and relevant management agencies (Fisheries New Zealand and DOC)—this will help with understanding what species may be an issue for your survey area and what level of bycatch to expect.
- Develop a plan for managing any bycatch that may occur during the survey, including preparing for the ability to safely handle and release the range of species that could be anticipated to be bycaught.
- Make sure that you are familiar with any particular protocols for reporting bycatch of any protected species.

Lobsters within pots are more susceptible to predation by octopuses (Booth 2011), and it is likely that there will be a low level of lobster injury and/or mortality from octopus predation during your survey. Avoiding long soak times is one way to reduce octopus predation.

While pots are usually weighted to avoid them moving during large swells, pots can damage erect benthic species, such as algae and sponges, in the footprint of the pot, and also if they are dragged along the seabed during hauling (e.g. Casement & Svane 1999; Eno et al. 2001). While this footprint will likely be small in the context of the wider survey area, the presence of particularly rare and/or fragile species should be considered during the survey design.

There is some evidence, particularly from American lobster fisheries where the effort is very high, that lobster bait can provide a significant supplement to the diet of lobsters (Saila et al. 2002; Grabowski et al. 2010). Lobster bait, either within baited pots, or as discards, provides a food source for lobsters that are caught and then released (e.g. if they are undersized) and potentially also for lobsters outside pots. Discarding bait within your survey area may also affect the distribution of lobsters and therefore influence your survey results. In managing potential effects relating to this, you should consider discarding uneaten bait beyond lobster habitat, outside your survey area or perhaps on shore.

Effects of lobster handling

Lobsters can be susceptible to sunlight itself and to the drying effects of the sun and wind—particularly their gills, eye stalks and egg clutch. To avoid any adverse effects, the period of time that lobsters need to be retained out of the water should be as short as possible. You may need to use a small tarpaulin or the lid of a fish bin to cover lobsters that need to be out of the water for any more than a few minutes. You may also need to regularly pour fresh seawater over them (using a bucket or deck hose). In some instances, you may need to keep lobsters in a tank of running seawater prior to release. In deciding what is best for the situation, consider:

- The environmental conditions (air temperature, wind, rain, cloud cover)
- The vessel being used (Is there cover available?)
- The number of lobsters you will likely need to handle (How quickly can you process an individual lobster, and how many lobsters per pot do you anticipate?)
- Any conditions that your Fisheries New Zealand Special Permit, Animal Ethics Committee approval or any other relevant permit specify

Experience will be needed in handling live lobsters to avoid unintended injury. Lobsters readily lose limbs (including legs and antennae), and although they will be replaced, the loss of any more than two limbs will affect the lobster's ability to grow after its next moult (Brouwer et al. 2006), as the lobster's resources are put into growing new limbs rather than increasing body size. Care should also be taken to avoid injury to the softer areas of the lobster's carapace, such as the tail fan and pleopods.

When releasing lobsters back into the sea, release them as close to the water's surface as you can safely, and also consider the presence of any predators (e.g. large seabirds and fish may prey on small lobsters released at the surface).

Field methodology

Again, the particular methodology you employ will depend on your objectives and also on aspects such as logistical requirements and safety issues. The following field procedure is based on the potting methodology employed in Freeman (2008).

Roles and responsibilities

Using this methodology requires at least three personnel in the field, but preferably four.

Skipper

The skipper has responsibility for the safety of the vessel and those aboard the vessel, and for the vessel's operation. They should provide input into the design of the survey and the day-to-day undertaking of the survey. They are most familiar with the vessel's capabilities and will be able to provide input into where and when the vessel can safely operate. They should also provide input into the sequencing of pot setting and retrieval during the survey so that factors such as weather conditions and presence of other fishing vessels or gear can be considered.

Achieving the survey's objectives should *always* be secondary to the safety of the vessel and those aboard. The skipper should always have final say over how the day-to-day operational aspects of the survey are undertaken.

Depending on the design of the vessel, you may or may not have direct access to the skipper. On smaller vessels you may be located next to the skipper and have easy communication, but on larger vessels you may be located some distance from the helm. Be sure to agree on best communication methods with your skipper.

Deckhand

The deckhand will usually be the person handling the pots, including deploying and retrieving pots, rebaiting pots and organising the pots and related equipment on the deck. They are acutely aware of the risks around these activities—take notice of them as they move about the vessel and obey their instructions. Stay well clear when pots are being deployed and retrieved.

The deckhand will likely also unload the lobsters from the pot for you and may also be able to assist with handling the lobsters—particularly useful with large lobsters (which can be difficult to hold with one hand while you are measuring with the other), and for occasions where you may be tagging as well as measuring lobsters. If you are tagging, it can be easier if you are wearing thinner or no gloves, but for handling lobsters you will need to wear thick gloves.

Sampler

The sampler will be the person who samples each pot and each lobster during the survey. They will be measuring and sexing lobsters, noting observations and working with the skipper and deckhand to ensure successful completion of the survey. They may also fulfil the role of recorder, particularly if there are few lobsters, and/or in instances where particular technical equipment is used (such as digital callipers, data loggers etc.) and if there are logistical constraints around personnel on the vessel.

Recorder

The recorder's role is to document the data that the sampler collects. The sampler should call out to the recorder all of the required data; the recorder may need to prompt the sampler if particular details have not been provided. The recorder may also ensure that GPS information for each pot is being recorded and may also be able to assist with holding and providing any equipment the sampler may need.

Media and communications

Depending on your survey location and on any permit conditions, you may wish to produce a public notice or media article advising the public of your intended survey. This may be particularly important if you are intending to conduct all or part of your survey within a closed area (such as a marine reserve).

Deploying and retrieving pots

Each vessel will be different in the way the skipper prefers to deploy and retrieve lobster pots; your survey design will also dictate how, where and when your pots are deployed and retrieved (e.g. whether pots are deployed and retrieved in groups or individually).

Deploying and retrieving pots will normally be undertaken by the skipper and deckhand, but be sure to confirm this before the survey starts.

Try to observe the pot as it nears the surface, as you may be able to see whether there are lobsters sitting on top of the pot (that may have been pot guarding). You may also be able to see whether any bycatch escapes before the pot surfaces. Often octopuses will leave the pot just before it breaks the surface; their presence may be important in influencing the pot catch, so you should record this information.

As the pot is brought on to the boat, the sampler should call out to the recorder the pot number (this should be written on the float), whether there is any bycatch (what species and how many; whether they are alive or dead), and also call out if the pot is empty. The recorder may take note of the GPS position at this point (or alternatively when the pot was deployed).

Either the sampler or the deckhand should remove the lobsters from the pot. If there are just a few lobsters then you may wish to measure and sex each lobster as it is removed from the pot. If there are many lobsters, it may be easier (and better for the lobsters) to remove them into a shaded fish bin (or holding tank) prior to processing.

The sampler should note to the recorder whether there are any empty lobster shells or dead lobsters in the pot. If they are measureable, follow the procedure below for recording lobster data.

Recording lobster data

Where possible, it is more efficient to have one person handling the lobster (the ‘sampler’) and one person recording the data (the ‘recorder’). This allows the recorder to have their hands free to write, allows them to stay relatively dry and clean (which may be important if they are using a laptop or tablet) and will speed up the whole process, allowing the lobsters to be returned to the sea as soon as possible. The sampler should call out the data for recording as clearly as possible.

Some general points on recording data in the field:

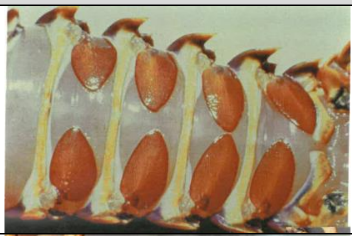
- Be aware and test out pencil types on waterproof paper. Some pencils can easily smudge or rub out, making it difficult or impossible to interpret the field sheets later.
- Always be clear whether you are recording a ‘blank’ or a zero value—this can be critically important when you come to analyse your data.

A suggested procedure for recording data for all live lobsters is:

1. A live lobster is selected from the pot catch (do not measure dead lobsters).
2. The maturity of the lobster (including sex) is assessed according to the scale provided in Table 5.
3. Carapace length is measured using vernier callipers, generally to the nearest 0.1 mm, from the base of the antennal platform to the dorsal posterior margin of the carapace (where it meets the tail) along the midline (see Figure 12). (Note: This may not always be required to be measured; you may choose only to record tail width.)
4. Tail width is measured using vernier callipers to the nearest 0.1 mm, between the tips of the primary spines on the second segment on the underside of the tail (see Figure 13).
5. The presence of any missing limbs is noted—new injuries are usually white, soft and moist; old injuries have 'sealed' and are usually pale brown, semi-hard and may appear dry.
6. You should note any other observations, which may include details such as:
    a. Presence of other injuries or deformities
    b. Unusual colouration of carapace or eggs
    c. Presence of any tags (record details of tag position, tag colour, tag number and any other details on the tag such as phone number)
    d. Presence of a soft shell (indicating recent moulting)
    e. If the lobster is dead (include any notes on possible cause, such as octopus predation)
7. Once the lobster has been measured, sexed, and all relevant data recorded, it should be returned to the sea immediately, at the location where it was captured.

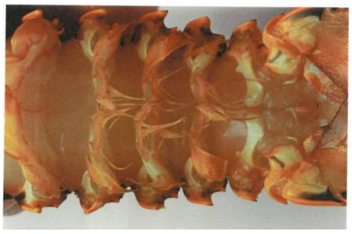
Table 5. Guide to recording lobster maturity, using readily observable physical characteristics. You may also use the stage ‘0’ where maturity is not recorded, and ‘9’ for a female where maturity is not recorded.

<table>
<tr><th>Stage</th><th colspan="2">Description</th><th>Photograph</th></tr>
<tr><td>1</td><td colspan="2">Male

Single pleopods.
5th walking leg is NOT clawed.
Gonopore is at the base of the 5th leg.</td><td></td></tr>
<tr><td>2</td><td rowspan="6">Female
(stages 2–7)

Double pleopods.

5th walking leg is clawed.

Gonopore at base of 3rd leg.</td><td>Immature
Pleopods have no setae, or setae that are shorter than 6 mm.</td><td></td></tr>
<tr><td>3</td><td>Mature
Pleopods have setae that are longer than 6 mm.</td><td></td></tr>
<tr><td>4</td><td>Berried
Eggs have no eyes.</td><td></td></tr>
<tr><td>5</td><td>Berried
Eggs have eyes.</td><td></td></tr>
<tr><td>6</td><td>Spent
Discoloured, matted setae.

Eggs still present.</td><td></td></tr>
<tr><td>7</td><td>Spent.
Discoloured, matted setae.

No eggs visible.</td><td></td></tr>
</table>

Figure 12. Measuring lobster carapace length. Callipers should be placed at the base of the antennal platform and at the posterior end of the carapace, at the insertion of the tail. Length is measured along the midline of the carapace.

Figure 13. Measuring lobster tail width. Callipers should be placed at the tips of the primary spines on the second segment on the underside of the tail.

Discarding bait

Uneaten and leftover bait should be discarded well away from reef habitat to avoid unintended potential effects on lobster abundance and distribution.

Data entry

In the field

A range of options are available for data entry in the field (including laptops, tablets, handheld field computers and data loggers). To assist with standardisation, DOC's Marine Ecosystems Team has developed two template field data sheets:

- Lobster potting field sheet 1—pot deployments (doccm-2787556)[3]
- Lobster potting field sheet 2—lobster measurements (doccm-2787557)[4]

On each day of the survey, fill out the top section of 'Lobster potting field sheet 1—pot deployments':

LOBSTER POTTING FIELD SHEET 1—POT DEPLOYMENTS	USE NEW SHEETS EVERY DAY	DOCCM-2787556
DOC Region:		Contractor:
District Office:		Contract number:

Date ___/___/_____	Recorder for this data:	Wind speed yesterday (knots):	Wind speed today (knots):
Survey leader:	Measurer:	Wind direction yesterday:	Wind direction today:
Location:	Vessel:	Swell direction yesterday:	Swell direction today:
Lunar stage:	Skipper:	Swell height yesterday (m):	Swell height today (m):

UID	Pot #	Date/Time deployed	Date/Time retrieved	Way point	Latitude	Longitude	Depth	Site	Protection status	Pot type	Habitat	Notes

Each pot should be individually numbered and the details of the deployment are to be recorded on the same data sheet.

The following day, the vessel returns to the location of each deployed pot and the pot is retrieved. Record 'Depth' and 'Date/Time retrieved' on 'Lobster potting field sheet 1—pot deployments'.

Record the information for each lobster on 'Lobster potting field sheet 2—lobster measurements':

LOBSTER POTTING FIELD SHEET 2—LOBSTER MEASUREMENTS **USE A NEW SHEET EVERY DAY**

One line to be filled per lobster **DOCCM-2787557**

Pot pick up date ___/___/_____ Location:

Recorder of this data: Survey leader name:

UID	Pot #	Time retrieved	Rock lobster (RL) or packhorse (PH)	Sex / Reproductive stage	Tail width (mm)	Carapace length (mm)	Scale of tail fan necrosis (or y/n)	Moulted (y/n)	New tag number	Tag number if recapture	# old injuries	# new injuries	Notes (e.g. Is the lobster dead? If so, why? Bycatch species?)

[3] http://www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/im-toolbox-marine-lobster-potting-field-sheet-1-pot-deployments.pdf

[4] http://www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/im-toolbox-marine-lobster-potting-field-sheet-2-lobster-measurements.xlsx

On return from the field

The key is to have firstly the raw data in a secure place, and also the final digital version of the data in a standardised format that is accessible, secure and easily interpreted by others at a later date. DOC's Marine Ecosystems Team has developed a form for entering lobster potting data, which provides a single Excel file with all data from a lobster potting survey, including relevant metadata.

Data need to be entered into the national lobster potting data entry form: 'Lobster potting—data spreadsheet and form' (doccm-2543532).[5] The fields that the data enterer will be prompted to record data in are provided in Table 6. Not all of these fields are mandatory and there is flexibility to add additional data fields if required. For detailed instructions, see 'Marine: how to use the lobster potting user form' (doccm-2582714).[6]

Once data have been submitted, they will undergo some quality control checks. If there are problems with the data, you will be contacted to resolve the issues. If there are no problems with the data, you will receive an email notifying you that the dataset has been submitted to the national dataset.

Post-monitoring checklist:

- ☐ All data sheets immediately scanned and uploaded as PDFs
- ☐ Data sheets checked for any data discrepancies and issues resolved as much as possible
- ☐ Updated data sheets are scanned in an appropriate order and uploaded as PDFs
- ☐ Data are entered into the lobster potting user form and submitted to the database

[5] http://www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/im-toolbox-marine-lobster-potting-data-spreadsheet-and-form.xlsm
[6] http://www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/im-toolbox-marine-how-to-use-the-lobster-potting-user-form.pdf

Table 6. Data fields available in the standardised data entry form. Not all are mandatory and many will roll across (e.g. fields such as location and lunar phase will only need to be entered once).

Field name in spreadsheet/database	Description	Value	Null value accepted?
RowID	An incremental number starting at 1. This number is unique to the specific observation record in a survey it refers to. It is also used as primary key in the database table.	Long integer, 12 digits. System generated in the database.	No
ObservationID	A unique code identifier for the observation. This code is unique to the specific record in a survey it refers to. It is also unique for the encoder and data entry date, counting records encoded by a specific user on a specific date. Made of <'LOBSTER_POTTING_'>||<username>||<entry date>||<'99999'>. <username> is <first letter from ***EncoderName***>||<all letters after the first blank in ***EncoderName***>. <entry date> is <***DateEntry*** converted to YYYYMMDD>. **Example**: '**LOBSTER_POTTING_gkessel2016070500001**' <encoder system user name> = 'gkessel' <entry date> = '20160705' <entry date record number> = '00001'	Alphanumeric of maximum length 79: • 16 for LOBSTER_POTTING_ • maximum of 50 characters for user name • 8 for entry date • 5 for daily entry date record number	No
EncoderName	Name (first name + last name) of the person who encoded the data in this spreadsheet.	Text (< 100 char)	No
DateEntry	Date at which the record was entered in this spreadsheet.	Date (dd/mm/yyyy)	No
ScanFieldSheetsDeploy	A hyperlink from DocCM to the scans of the field sheets used to gather the information on pot deployment. There could be several hyperlinks but one is preferred.	Hyperlink taken from DocCM, the file manager software of DOC.	No
ScanFieldSheetsLobster	A hyperlink from DocCM to the scans of the field sheets used to gather the information on lobsters collected in each pot deployment. There could be several hyperlinks but one is preferred.	Hyperlink taken from DocCM, the file manager software of DOC.	No
LinkToReport01	Hyperlink to DocCM for any report(s) related to these data. Up to 4 links to reports available.	Hyperlink taken from DocCM, the file manager software of DOC.	Yes
LinkToReport02	Hyperlink to DocCM for any report(s) related to these data. Up to 4 links to reports available.	Hyperlink taken from DocCM, the file manager software of DOC.	Yes
LinkToReport03	Hyperlink to DocCM for any report(s) related to these data. Up to 4 links to reports available.	Hyperlink taken from DocCM, the file manager software of DOC.	Yes
LinkToReport04	Hyperlink to DocCM for any report(s) related to these data. Up to 4 links to reports available.	Hyperlink taken from DocCM, the file manager software of DOC.	Yes

Field name in spreadsheet/database	Description	Value	Null value accepted?
LinkToOriginalData	Hyperlink to DocCM for the spreadsheet where these data were initially encoded.	Hyperlink taken from DocCM, the file manager software of DOC.	No
LinkToPicture	Link to location on the S drive where pictures of fieldwork have been saved.	Hyperlink	Yes
SurveyID	A unique code identifier for this survey. Made of <***SurveyLocation*** field abbreviated as 3 letters>|| '_' ||<date of start of survey (YYYYMMDD)>||'_'||<method abbreviated as 3 letters>. **Example:** A lobster potting survey in Gisborne MR (Te Tapuwae o Rongokako Marine Reserve) that started on 15 Feb 2016 would be named: **RON_20160215_POT** **Note:** ***SurveyID*** is not unique for the observation record. All observation records entered for the same survey will have the exact same code.	Alphanumeric, 16 characters. Official abbreviations for ***SurveyLocation*** can be found in 'Marine protected area list and abbreviations' (doccm-2770061).[7]	No
SurveyName	A name for this survey. Allows to differentiate surveys achieved at different dates at similar location. It is linked to the ***SurveyID*** field. **Example:** '**Lobster potting Poor Knights Feb 2015**'.	Text (<100 char)	No
SurveyType	Type of survey, according to selected research method/data sampling method. Takes the value of 'Lobster potting' for all surveys.	Text (< 100 char) with 'Lobster potting' as default value.	No
SurveyLocation	Name of a geographic location in New Zealand where the whole survey is performed as a research event.	Text (< 100 char)	No
SurveyStartDate	Official date when a survey started as a research event.	Date (dd/mm/yyyy)	No
SurveyVerbatim	An exhaustive description of the survey design and objectives.	Text (< 3000 char)	No
NotesSurvey	Any additional notes on this survey.	Text (< 3000 char)	Yes
Region	Partnership region where the survey was carried out.	One of 9 values from the list as current from 31 Oct 2016.	No
OfficeName	DOC Office responsible for this survey.	One of the drop-down list values.	No
OfficeContact	Name (first name + last name) of the key contact in DOC Office who was related to this survey. This might be different to the person managing the Office.	Text (< 100 char)	No
ContractorName	Name of person/company contracted to carry out the survey, if applicable.	Text (< 100 char)	Yes
ContractNumber	Contract number for this survey.	Text (< 20 char)	Yes
LinkToContract	Hyperlink to DocCM for the contract related to this survey.	Hyperlink	Yes
SurveyLeaderName	Name (first name + last name) of the person in charge of this survey.	Text (< 100 char)	No

[7] http://www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/im-toolbox-marine-marine-protected-area-list-and-abbreviations.xlsx

Field name in spreadsheet/database	Description	Value	Null value accepted?
LinkToMarineReserve	Indicates to which marine reserve the data collected during this survey is linked. If this survey includes control sites (i.e. sites outside a marine reserve), the name of the marine reserve they relate to should be selected here.	One of the drop-down values from the list comprising all the marine reserves of the country.	No
MarineReserveID	ID number as taken from NaPALIS database for marine reserve. Only Type I protected areas (marine reserves) have a NaPALIS ID number. Other protected areas of Type II do not have this number.	Integer	Yes
IsLongTermMonitoring	Indicates whether this survey is part of ongoing, long-term monitoring at these sites.	One of two values: 'TRUE' or 'FALSE'.	No
StratifiedBy	Indicates whether the sampling design was stratified for a specific factor (depth, habitat, exposure, or another factor).	One of nine values: 'Depth', 'Habitat', 'Exposure', 'DepthxHabitat', 'DepthxExposure', 'HabitatxExposure', 'DepthxHabitatxExposure', 'Other' or 'None'.	No
SiteSelectionDesign	Indicates the type of design for site selection used in this study. Most of the time for sites they will have been chosen either randomly within an area or non-randomly (and often chosen because the experimenter knows they are good sites for diving).	One of seven values: 'Non-random', 'Non-random paired sites', 'Random', 'Random (1 pot deployed per site)', 'Randomised block design', 'Other' or 'Undetermined'.	No
UnitSelectionDesign	Indicates the type of design for selection of the location for pot deployment used in this study. Most of the time for pots they will have been chosen haphazardly within a site, i.e. not in an absolute random way but without a priori choice made by the observer.	One of five values: 'Haphazard', 'Random', 'Random (1 pot per site)', 'Other' or 'Undetermined'.	No
RightsHolder	A person(s) or organisation(s) owning or managing rights over the resource. This will usually be DOC but sometimes data will be collected by external groups like universities leading to shared rights over the data.	Text (< 100 char). Must be 'Department of Conservation, New Zealand Government' if data rights belong to DOC.	No
AccessRights	Information about who can access the resource or an indication of its security status.	Text (< 1000 char)	Yes
DataSecurityLevel	Defines the security level for this data.	Text (< 100 char)	No
SiteLocation	General locality where the sampling unit was deployed. **Example:** '**Poor Knights Islands**' **Note:** ***SiteLocation*** refers to the same location as described in ***SurveyLocation*** for simple surveys performed in one marine reserve. In complex areas like Fiordland, ***SiteLocation*** is a smaller geographic area that belongs to a larger ***SurveyLocation***.	Short text (< 100 char)	No

<table>
<tr><th>Field name in spreadsheet/database</th><th>Description</th><th>Value</th><th>Null value accepted?</th></tr>
<tr><td>SiteID</td><td>A unique identifier to a site, a site being defined as an area within a location where a number of pots have been deployed in close vicinity.
Made of SurveyLocation field abbreviated as 3 letters>||'_'||< a 3-digit number>.
Example: A first site sampled at Gisborne MR (Te Tapuwae o Rongokako Marine Reserve) would be identified as RON_001. A second site would be named RON_002.
Note: The 3-letter abbreviations are related to marine reserve names but will also be used for control sites in non-protected areas (i.e. a SiteID for a control site of Te Tapuwae o Rongokako Marine Reserve could be named RON_003).</td><td>7 characters (text+digit).
Official abbreviations for SurveyLocation can be found in 'Marine protected area list and abbreviations' (doccm-2770061).[8]</td><td>No</td></tr>
<tr><td>SiteName</td><td>The vernacular or common name of a site located within SurveyLocation where the pot was deployed. This field is linked to SiteCode and both should identify the same site.
Note: SiteID is the main reference code to define a site.</td><td>Text (< 100 char)</td><td>Yes</td></tr>
<tr><td>SiteCode</td><td>A code, usually consisting of a few letters and/or numbers, that refers to a specific site. This field is linked to SiteName and both should identify the same site.
Note: May be only a historical reference not useful for recent collections. It is of no value as a robust reference for sites.
Note: SiteID is the main reference code to define a site.</td><td>Text (< 20 char)</td><td>Yes</td></tr>
<tr><td>ProtectionStatus</td><td>Indicates the protection status of the area being sampled.</td><td>One of the six values: 'Type I MPA (Marine Reserve)', 'Type II MPA', 'Mātaitai', 'Taiāpure', 'Other protection' or 'No protection'.</td><td>No</td></tr>
<tr><td>ProtectionStatusDetails</td><td>Gives further details on the protection status. This is important information to provide for all marine protected areas that have specific rules associated to them. An exception is Type I marine protected areas where rules of protection are clearly defined.</td><td>Text (< 3000 char)</td><td>Yes</td></tr>
<tr><td>IsControlSite</td><td>Indicates whether this site is a control site for data collected in a specific marine reserve.</td><td>One of two values: 'TRUE' or 'FALSE'.</td><td>No</td></tr>
<tr><td>ControlToMR01</td><td>If IsControlSite is TRUE, then enter here the name of the marine reserve this control site refers to. (You can name up to three marine reserves.)</td><td>One of the drop-down values from the list comprising all the marine reserves of the country.</td><td>Yes</td></tr>
<tr><td>ControlToMR02</td><td>If IsControlSite is TRUE, then enter here the name of the second marine reserve this control site refers to.</td><td>One of the drop-down values from the list comprising all the marine reserves of the country.</td><td>Yes</td></tr>
<tr><td>ControlToMR03</td><td>If IsControlSite is TRUE, then enter here the name of the third marine reserve this control site refers to.</td><td>One of the drop-down values from the list comprising all the marine reserves of the country.</td><td>Yes</td></tr>
</table>

[8] http://www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/im-toolbox-marine-marine-protected-area-list-and-abbreviations.xlsx

Field name in spreadsheet/database	Description	Value	Null value accepted?
SiteExposure	Indicates how exposed the site is that is being surveyed.	One of four values: 'Sheltered', 'Intermediate', 'Exposed', or 'Undetermined'.	No
UnitID	A unique identifier for this pot deployment. Made of <***SurveyID***>||'_'||<4-digit incrementing number>. Each pot (=sampling unit) can have zero (null sample), one or more observations. **Example**: ***UnitID*** for the first pot deployed in the first site of a survey that started on 15 Feb 2016 at Gisborne MR (Te Tapuwae o Rongokako Marine Reserve) would be: **RON_20160215_POT_0001** A second pot deployed at the same site during the same survey would be named: **RON_20160215_POT_0002** A third pot on a second and different site would be named: **RON_20160215_POT_0003** **Note:** Do not confuse this field with the ***ReplicateWithinSite*** field. Pots are counted for a survey, not per site. Counting per site is recorded in the ***ReplicateWithinSite*** field.	21 characters (text+digit). Official abbreviations for ***SurveyLocation*** can be found in 'Marine protected area list and abbreviations' (doccm-2770061).[9]	No
ReplicateWithinSite	Allows identifying a specific pot within a site. The pots are the lowest and most important sampling units of a survey. Investigators will deploy *x* number of pots per site during a survey. Ideally, each site should have the same number (*x*) of replicates, but it is not impossible that this number differs between sites for logistical reasons. **Note 1:** Do not confuse this field with the ***UnitID*** field. **Note 2**: If several depth strata have been sampled at this site, do not restart ***ReplicateWithinSite*** at 1 for each new stratum, but rather keep increasing the value from the highest value of the last depth stratum (e.g. 12 pots deployed within 3 depth strata at 1 site will have ***ReplicateWithinSite*** values going from 1 to 12—not 3 times 1 to 4).	Integer from 1 to *x*, with *x* representing the total number of pots deployed at one specific site (1–999). Must take value < 999	No
PotNumber	A number given to each pot. This number is usually physically imprinted on the buoys from the buoy line used to deploy the pot. This means that a pot can actually have a different number on a following survey (if the buoy lines have been changed).	Integer (≤ 50 but < 67 for historical records only).	No
EventDateStart	Date at which the pot was deployed.	Date (dd/mm/yyyy)	No
EventDateEnd	Date at which the pot was recovered.	Date (dd/mm/yyyy)	No
Year	Year at which the pot was retrieved (not deployed).	Integer (> 1980 and ≤ 9999)	No
Month	Month of year at which the pot was retrieved (not deployed).	Integer (1 to 12)	No
EventTimeStart	Time at which the pot was deployed.	Time in 24h format (hh:mm)	No
EventTimeEnd	Time at which the pot was retrieved.	Time in 24h format (hh:mm)	No

[9] http://www.doc.govt.nz/documents/science-and-technical/inventory-monitoring/im-toolbox-marine-marine-protected-area-list-and-abbreviations.xlsx

Field name in spreadsheet/database	Description	Value	Null value accepted?
SoakTime	Indicates the number of hours the pots were left to soak (can be entered as an alternative to '*EventTimeStart*' and '*EventTimeEnd*' fields for historical data).	Number	Yes
LunarPhase	Phase of the moon at the time of sampling.	One of the eight values: 'New', 'Waxing Crescent', 'First Quarter', 'Waxing Gibbous', 'Full', 'Waning Gibbous', 'Third Quarter', 'Waning Crescent'.	No
DaysSinceNewMoon	Number of days since the last new moon.	Integer	No
LunarIllumination	The proportion of lunar illumination at *EventDateStart*. A value of 100% indicates a full moon, and 0% a new moon. Calculated with the 'lunar.illumination' function from the R package 'lunar'.	Number (0.0–100.0)	Yes
Vessel	Vessel used to deploy the pots.	Text (< 100 char)	Yes
SkipperName	First and last name of the skipper.	Text (< 100 char)	No
DepthDeployment	Indicates the depth in metres at the time of pot deployment. Not corrected for tides. Depth can be collected using different methods (see *DepthCollectionMethod*, e.g. sonar on board the research vessel or extracted from latitude/longitude information from bathymetric data layer). Depth can also be corrected for tide or not (see *DepthTidalCorrection*).	Number (0.0–99.9)	No
DepthRetrieval	Indicates the depth in metres at the time of pot retrieval. Not corrected for tides. Depth can be collected using different methods (see *DepthCollectionMethod*, e.g. sonar on board the research vessel or extracted from latitude/longitude information from bathymetric data layer). Depth can also be corrected for tide or not (see *IsTideCorrected*).	Number (0.0–99.9)	No
DepthCollectionMethod	Indicates by which method the information in *DepthDeployment* and *DepthRetrieval* has been collected.	One of two values (might be more in the future): 'Extracted from lat/long and bathymetric data' or 'Research vessel onboard sonar'.	No
IsTideCorrected	Indicates whether the values in *DepthDeployment* and *DepthRetrieval* have been corrected for tide.	One of two values: 'TRUE' or 'FALSE'.	No
DepthStrata	Depth stratum within which the pot was deployed. The investigator might not have designed different depth strata for his/her study. In this case, a general value encompassing the depth range at which the survey occurred should be entered (e.g. 5–25 m). **Example: 5–15 m** or **16–25 m**	Short text typically made of 5 or 6 characters for pots deployed shallower than 99 m of water depth.	Yes
CoordinatesPrecision	An estimate of how tightly the locality was specified in the *Latitude* and *Longitude* fields; expressed as a distance, in metres, that corresponds to a radius around the latitude–longitude coordinates. Use NULL where precision is unknown, cannot be estimated, or is not applicable.	Integer (likely values 1–50,000) but not 0.	No

Field name in spreadsheet/database	Description	Value	Null value accepted?
Latitude	Decimal degree latitude of the pot deployment (WGS84). **Example**: Latitude for Wellington Conservation House is **−41.289904**	Number with up to 6 digits after decimal. Values are between −90 to 90, but typically negative for New Zealand.	No
Longitude	Decimal degree longitude of the pot deployment; east of Greenwich (WGS84). **Example**: Latitude for Wellington Conservation House is **174.775043**	Number with up to 6 digits after decimal. Values are between 0 and 360.	No
Habitat	Brief description of the nature of the seabed (mud, sand, gravel, cobbles, rocky reef, kelp forest…)	Text (< 1000 char)	Yes
IsMoreHabitatData	Informs if there is additional information on habitat where this pot was deployed.	One of two values: 'TRUE' or 'FALSE'.	No
NZMHCS_abiotic	A number taken from Table 5 of the New Zealand Marine Habitat Classification Scheme (draft document not available to the public)	Integer up to 4 digits.	Yes
NZMHCS_biotic	A number taken from Table 6 of the New Zealand Marine Habitat Classification Scheme (draft document not available to the public).	Integer up to 4 digits.	Yes
Weather	Description of the atmospheric conditions of the day (wind, sea state, swell…)	Text (< 1000 char)	Yes
WindSpeedYesterday	Mean wind speed in knots at the site yesterday.	Number	No
WindDirectionYesterday	Direction of the wind at the site yesterday.	One of sixteen values: 'N', 'NNE', 'NE', 'ENE', 'E', 'ESE', 'SE', 'SSE', 'S', 'SSW', 'SW', 'WSW', 'W', 'WNW', 'NW', 'NNW'.	No
SwellDirectionYesterday	Direction of the swell at the site yesterday.	One of sixteen values: 'N', 'NNE', 'NE', 'ENE', 'E', 'ESE', 'SE', 'SSE', 'S', 'SSW', 'SW', 'WSW', 'W', 'WNW', 'NW', 'NNW'.	No
SwellHeightYesterday	Height of the swell in metres at the site yesterday.	Number	No
WindSpeedToday	Mean wind speed in knots at the site for today.	Number	No
WindDirectionToday	Direction of the wind at the site today.	One of sixteen values: 'N', 'NNE', 'NE', 'ENE', 'E', 'ESE', 'SE', 'SSE', 'S', 'SSW', 'SW', 'WSW', 'W', 'WNW', 'NW', 'NNW'.	No
SwellDirectionToday	Direction of the swell at the site today.	One of sixteen values: 'N', 'NNE', 'NE', 'ENE', 'E', 'ESE', 'SE', 'SSE', 'S', 'SSW', 'SW', 'WSW', 'W', 'WNW', 'NW', 'NNW'.	No
SwellHeightToday	Height of the swell in metres at the site today.	Number	No

Field name in spreadsheet/database	Description	Value	Null value accepted?
PotType	Type of pot used (e.g. 52 mm mesh HRC).	Text (< 100 char)	No
BaitSpecies	Species that was used as bait for the deployment.	Text (< 150 char)	No
BaitAmount	Amount of bait that was used (g) with this pot.	Integer	No
PotLength	Length of the pot (mm).	Integer	No
PotWidth	Width of the pot (mm).	Integer	No
PotHeight	Height of the pot (mm).	Integer	No
PotEscapeLength	Length of the escape gap of the pot (mm).	Integer	Yes
PotEscapeWidth	Width of the escape gap (mm).	Integer	Yes
PotEscapeNumber	The number of escape gaps in the pot.	Integer	No
PotMeshLength	Length of the mesh size of the pot (mm).	Integer	No
PotMeshWidth	Width of the mesh size of the pot (mm).	Integer	No
NotesPot	Any additional notes on this pot deployment.	Unlimited text	Yes
IsBycatchDataCollected	Indicates whether the observer has been collecting data on bycatch species taken in this pot. By bycatch species, we mean any other species that is not a lobster, found inside the pot when it was retrieved. A value set to 'FALSE' indicates that the observer has not been recording any information on bycatch specimens. **Note:** Do not confuse this field with ***IsBycatchSpecimensFound***.	One of two values: 'TRUE' or 'FALSE'.	No
IsBycatchSpecimensFound	Indicates if bycatch specimens were found in this pot. **Note:** Do not confuse this field with ***IsBycatchDataCollected***.	One of two values: 'TRUE' or 'FALSE'.	No
RecordID	A unique identifier for the specimen observation. Made of <***UnitID***>||'_'||<four-digit incrementing number>. **Example:** ***RecordID*** for the first observation for the first pot in the first site of a survey that started on 15 Feb 2016 at Gisborne MR (Te Tapuwae o Rongokako Marine Reserve) would be: ***UnitID*** = **RON_20160215_POT_0001** ***RecordID*** = **RON_20160215_POT_0001_0001** A second observation within the same pot would be: ***RecordID*** = **RON_20160215_POT_0001_0002**	Alphanumeric, 26 characters.	No
IsNullsample	Records whether a pot was deployed but no lobsters were caught in it. It is essential to keep a record of null samples. This field value should be set to TRUE if no specimens were found in this pot.	One of two values: 'TRUE' or 'FALSE'.	No

Field name in spreadsheet/database	Description	Value	Null value accepted?
IsQuickCount	Indicates whether lobster specimens from a pot could not be individually measured and were only counted and sexed.	One of two values: 'TRUE' or 'FALSE'. Takes value FALSE if *IsNullSample* = TRUE.	No
MeasuredBy	Name of the person who measured the lobster specimen.	Text (< 100 char). Takes value NULL if *IsNullSample* = TRUE.	Yes
RecordedBy	First and last name of the person who recorded on the field sheet the measurements made on the lobster.	Text (< 100 char)	No
DOCTaxonID	A unique identifier for this species in the DOC species reference database. It allows having continuity in taxonomy by linking it to the New Zealand Organisms Register (NZOR) and the World Register of Marine Species (WoRMS) reference databases, or the internal DOC species catalogue.	Integer (0–10,000). Takes value 0 if *IsNullSample* = TRUE. Takes value '999999' if value in *ScientificNameLobster* could not be matched with an appropriate Taxon ID.	No
ScientificNameLobster	Species of lobster specimen caught.	One of two values: 'Jasus edwardsi', 'Sagmariasus verreauxi'. Takes value 'N/A' if *IsNullSampleLobster* = TRUE.	No
IsLobsterDead	Did the specimen die during the sampling process?	One of two values: 'TRUE' or 'FALSE'. Takes value NULL if *IsNullSample* = TRUE.	Yes
LobsterDeadVerbatim	If obvious or known, detail the reason why the lobster specimen died during the sampling process (e.g. predation by octopus).	Text (< 200 char). Takes value NULL if *IsNullSample* = TRUE or if *IsLobsterDead* = FALSE.	Yes
IsTagged	Indicates whether the specimen is tagged. **Note:** Will take value TRUE if the specimen has been captured without a tag but is being released with a new tag; will also take value TRUE if the specimen was captured with a pre-existing tag.	One of two values: 'TRUE' or 'FALSE'. Takes value TRUE if tag newly installed on this specimen or if the specimen is equipped with a tag previously attached to it.	No
TagType	Indicates whether the specimen is newly tagged and released (after this capture) or if it is a recapture from a previous tagging event. **Note:** Tagged specimens that were recovered by fishermen are considered as part of a different sampling method. Accordingly, this information is stored in a separate table.	One of two values: 'New tag' or 'Recapture'.	Yes

Field name in spreadsheet/database	Description	Value	Null value accepted?
TagNumber	Tag number of the lobster specimen. Either the number of the new tag installed or the number of a recapture.	Text (5 char). DOC tags take values 'W0001' to 'W9999'. Takes value NULL if ***IsNullSample*** = TRUE or if no tag was added to specimen or found on specimen.	Yes
TagColour	Tag colour of the lobster specimen. Either the colour of the new tag installed or the colour of a recapture tag.	Text (< 20 char). Takes value NULL if ***IsNullSample*** = TRUE or if no tag added or found on specimen.	Yes
Sex	Sex of the lobster specimen.	One of three values: 'Male', 'Female' or 'Undetermined'. Takes value NULL if ***IsNullSample*** = TRUE.	Yes
ReproStage	Reproductive stage of the lobster specimen.	One of eight values: 1—Male (sexually mature or immature) 2—Immature female (no setae on pleopods, or setae less than 6 mm in length) 3—Mature but non-egg-bearing female (setae on pleopods longer than 6 mm in length; no egg mass present) 4—Mature egg-bearing female (eggs without visible eyes) 5—Mature egg-bearing female (eggs with visible eyes) 6—Mature female (eggs released; traces of eggs may remain on setae; setae appear matted) 7—Mature female (eggs released; discoloured matted setae) 9—Female, maturity not determined Takes value NULL if ***IsNullSample*** = TRUE.	Yes

Field name in spreadsheet/database	Description	Value	Null value accepted?
IsTailFanNecrosis	Presence of tail fan necrosis on the lobster specimen.	One of two values: 'TRUE', 'FALSE'. Takes value NULL if ***IsNullSample*** = TRUE.	Yes
TailFanNecrosisScale	Scale of tail fan necrosis on the lobster specimen.	One of five values: 0—Necrosis absent (no obvious signs of blistering or blackened areas on any part of the lobster) 1—Necrosis present (small (< 2 × 2 cm) area of blistering or blackening on telson or uropod) 2—Necrosis present (area > 2 × 2 cm showing blistering or blackening; generally more than one uropod and/or telson affected; uropod or telson occasionally missing) 3—Necrosis present (all uropods and telson affected to considerable extent by blistering and/or blackening) 4—Necrosis present (all uropods and telson affected to a large degree; necrosis spreading into muscle tissue in the tail) Takes value NULL if ***IsNullSample*** = TRUE.	Yes
CarapaceLength	Length of the carapace for the specimen (mm).	Number. Takes value 0 if ***IsNullSample*** = TRUE.	Yes
TailWidth	Width of the tail for the specimen (mm).	Number. Takes value 0 if ***IsNullSample*** = TRUE.	Yes
WeightLobster	Weight of the lobster specimen (g).	Number. Takes value 0 if ***IsNullSample*** = TRUE	Yes
WeightLobsterType	Indicates the way the weight has been given: measured or deducted from Length–Weight relationships.	One of two values: 'Measured' or 'L–W relationship'. Takes value NULL if ***IsNullSample*** = TRUE or if ***WeightLobster*** is NULL.	Yes

Field name in spreadsheet/database	Description	Value	Null value accepted?
IsLegalSize	Indicates whether the lobster is of a legal size.	One of two values: 'TRUE' or 'FALSE'. Takes value NULL if ***IsNullSample*** = TRUE.	Yes
IsMoulted	Indicates whether the lobster has moulted (can only be determined if it is a recapture).	One of three values: 'TRUE', 'FALSE' or 'Unknown'. Takes value NULL if ***IsNullSample*** = TRUE.	Yes
NumberOldInjury	Number of missing appendages where the exposed tissue has sealed, with visible scar tissue (usually yellow/brown in colour)..	Integer. Takes value NULL if ***IsNullSample*** = TRUE.	Yes
NumberNewInjury	Number of missing appendages where the exposed tissue is bright white, with no visible scar tissue.	Integer. Takes value NULL if ***IsNullSample*** = TRUE.	Yes
IndividualCountInPot	Total number of lobster specimens caught in the retrieved pot.	Integer. Takes value 0 if ***IsNullSample*** = TRUE.	Yes
NotesSpecimen	Space for any notes on that particular specimen.	Text (< 1000 char).	Yes

Data analysis

CPUE

CPUE can be calculated and presented as number of lobsters per pot lift or as wet weight of lobsters per pot lift. Both number and weight of lobsters can be split by sex and size (e.g. by presenting only legal-sized lobsters). The most common metric is wet weight (kg) of legal-sized lobsters per pot, as this provides a measure of fishable biomass.

While lobster weight can be measured at sea, it is far easier and efficient and often more accurate to measure tail widths and convert these to weight using standard conversions that are used in lobster fisheries stock assessments (e.g. Breen et al. 2009). The conversion to use depends on the particular fishery management area you are working in, and is different for males and females.

To convert tail width to wet weight, use the following equation and the parameters in Table 7.

$$\text{Wet weight} = a\text{TW}^{b}$$

Table 7. Length–weight parameters by sex and Quota Management Area (QMA) used to convert tail width measurements to total weight in kg.

	Males		Females	
QMA	a	b	a	b
1	4.160E-06	2.935	1.300E-05	2.545
2	4.160E-06	2.935	1.300E-05	2.545
3	4.160E-06	2.935	1.300E-05	2.545
4	4.160E-06	2.935	1.300E-05	2.545
5	4.160E-06	2.935	1.300E-05	2.545
6	3.394E-06	2.967	1.037E-05	2.632
7	3.394E-06	2.967	1.037E-05	2.632
8	3.394E-06	2.967	1.037E-05	2.632
9	3.394E-06	2.967	1.037E-05	2.632

To obtain CPUE for an individual pot, sum the weights of all individuals.

CPUE is determined in part by the size of your pots, so be sure to present CPUE data for each pot type you use—do not pool CPUE data from different pot designs unless you have previously tested for a statistical difference among them. Ideally, you should use the same pot type throughout your survey.

If you wish to present CPUE for particular sizes of lobster, consider your pot design (e.g. mesh size and escape gaps) and the minimum legal size limits in place for your survey area.

The simplest way to present CPUE data is as an arithmetic mean for the area and time—i.e. the total catch (in weight, legal weight, numbers or whatever is appropriate) divided by the number of pots. Confidence limits should be presented, based on the variability within the data. Changes over time can be presented as a graph with time on the *x*-axis.

Size and sex data

Size data are most informatively presented as size frequency histograms. These provide not only information about recruitment, growth and population structure, but may also provide information about the sizes of lobster that are affected by the particular management regime of your sample area. For example, in harvested populations you would expect a lower proportion of the lobster population to be above the minimum legal size limit relative to unfished populations. However, other aspects such as comparability between the fished and unfished habitat, levels of recruitment, and ecological interactions may also need to be considered when comparing size and sex data between fished and unfished areas (any observed differences may not solely be attributable to fishing intensity).

You should expect to see differences in sex ratio over both time and space and potentially in relation to management regime. Aspects such as seasonal migrations, differential catchability and selected harvesting may all influence the ratio of males to females within a particular population.

For females, the combination of size and sex data can provide you with information on the size at onset of maturity (or SOM). This is because the maturity of females can be readily discerned using external features (absence or presence of setae/'hairs' on the pleopods). Data can be analysed and presented in a number of ways, but assessing the percentage of females that are mature above a particular tail width or carapace length is one method. Similarly, reproductive stage can be presented as percentage of the females or particular sized females at each stage (this can provide insight into aspects such as mating and egg hatching). Estimates of 50% and 95% maturity can be made by fitting a logistic curve to the data using a binomial likelihood; these estimates can be sensitive to the timing of the surveys.

Safety

Safety is paramount during any survey activity. The safety recommendations below are provided as general guidance, but it is imperative that the survey leader understands all risks associated with the activity, always uses caution, and develops a Safety Plan for the survey activity and location (DOC staff should use Risk Manager, and non-Departmental staff should consult WorkSafe New Zealand's 4-step risk management[10] or their own organisation's safety plans. Safety Plans should include resources (e.g. equipment, boats, communication, support, personal protective equipment), environmental hazards or considerations (e.g. remoteness, surf zones), personnel (experience, training, physical and mental fitness), weather, and mission complexity. Following a thorough safety briefing, all team members should read and then sign the Safety Plan.

[10] http://www.worksafe.govt.nz/worksafe/hswa/health-safety/how-to-manage-work-risks

Specifically, it is recommended that:

- A minimum of three people make up the survey team
- All personnel should operate within the limits of their training and experience
- The magnitude and complexity of the survey are relevant for the planned duration of the survey

References and further reading

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Appendix A

Equipment and resources list

The following table provides a checklist of items you may need to consider in undertaking a lobster potting survey. Not all of these will be essential.

		Check
Permits and approvals	Fisheries New Zealand Special Permit	
	Animal Ethics Approval	
	DOC research permit	
	Consultation with whānau, hapū and iwi	
	Consultation with management committees and/or stakeholders	
	Health and safety plan	
Field resources	Appropriately equipped vessel and skilled crew	
	Pots, rope and named buoys	
	Bait	
	Callipers and lubricant (e.g. silicon)	
	Handheld GPS	
	Clean fish bins with lids (at least 2)	
	Marker pen for buoys	
	Gaff for retrieving hazardous bycatch	
	Small tarpaulin (or similar) to provide shade to lobsters	
Data	Clipboard	
	Waterproof pre-printed data sheets	
	Pencils (check beforehand to see which type works best on your waterproof paper)	
	Erasers	
Personal protective equipment	Wet weather gear	
	Gumboots	
	Sun protection	
	Gloves (thick waterproof and lobster-handling gloves)	
	Life jacket/vest	
	Hard hat (may be required on some vessels)	

Field data sheets

Print these field sheets on waterproof paper:

doccm-2787556 Lobster potting field sheet 1—pot deployments

doccm-2787557 Lobster potting field sheet 2—lobster measurements

Appendix B

The following Department of Conservation documents are referred to in this method:

doccm-2582714	Marine: how to use the lobster potting user form
doccm-2770061	Marine protected area list and abbreviations
doccm-2543532	Lobster potting—data spreadsheet and form
doccm-2787556	Lobster potting field sheet 1—pot deployments
doccm-2787557	Lobster potting field sheet 2—lobster measurements
doccm-1163829	MPAMAR metadata—national
doccm-146272	Standard inventory and monitoring project plan