

Dungeness Crab Research by the Wuikinuxv Nation:

Interim report for fieldwork conducted during May 2014



Wuikinuxv Guardian Watchmen, Brian Johnston and Chris Corbett, collecting data.

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Summary

We present results from a tagging study of Dungeness crab conducted by the Wuikinuxv Nation during May of 2014 at two sites of Rivers Inlet. Crabs were larger and—according to mark-recapture population estimates—*possibly* more abundant at Kilbella Bay than at Johnston Bay (6,855 vs. 4,740 estimated crabs, respectively). Uncertainty around population estimates, however, was large (CVs= 41.9% and 25.2%, respectively). During the three-week study period, Dungeness crabs were found mainly on shallow habitats and crab size did not vary with depth. Injury rates did not differ between sites. Experimental fishery closures are required to infer exploitation impacts from commercial and recreational fishers. Towards that end, a voluntary closure was attempted at Kilbella Bay. This closure failed, as 9 of 24 (38%) sport fishery captures of tagged crab occurred at that site. Collaboration from DFO is required to legislate fishery closures that might help infer exploitation impacts. The report concludes with recommendations for improving mark-recapture population estimates during future research.

Introduction

The four Central Coast Nations—Heiltsuk, Kitasoo/Xai'Xais, Nuxalk, and Wuikinuxv—are working together on marine use planning and fisheries management under the umbrella of the Central Coast Indigenous Resource Alliance (CCIRA). CCIRA-member Nations are experiencing declining catch rates for Dungeness crab in parts of their territories. Given that Dungeness crabs are critical to fisheries for Food, Social and Ceremonial (FSC) purposes, on April 2014 Central Coast Nations began to monitor Dungeness crabs within their territories.

This report focuses on data collected by the Wuikinuxv Nation at two site sites of Rivers Inlet during May of 2014. Namely, it provides data on relative abundance (catch per unit effort) and depth distribution, and *preliminary* estimates of size structure and population size. The population estimates were based on mark-recapture analyses led by John Boulanger. In addition to providing baseline data, we discuss recommendations on how field methodology might be improved for future work.

Methods

Field sampling

Working with Wuikinuxv Guardian Watchmen, we conducted fieldwork in Rivers Inlet for three weeks during the spring of 2014, prior to the annual rise of recreational fishing pressure associated with summer. Sampling and tagging of crabs occurred daily from April 30 to May 17 at Johnston Bay, and from April 30 to May 21 at Kilbella Bay (Fig. 1).

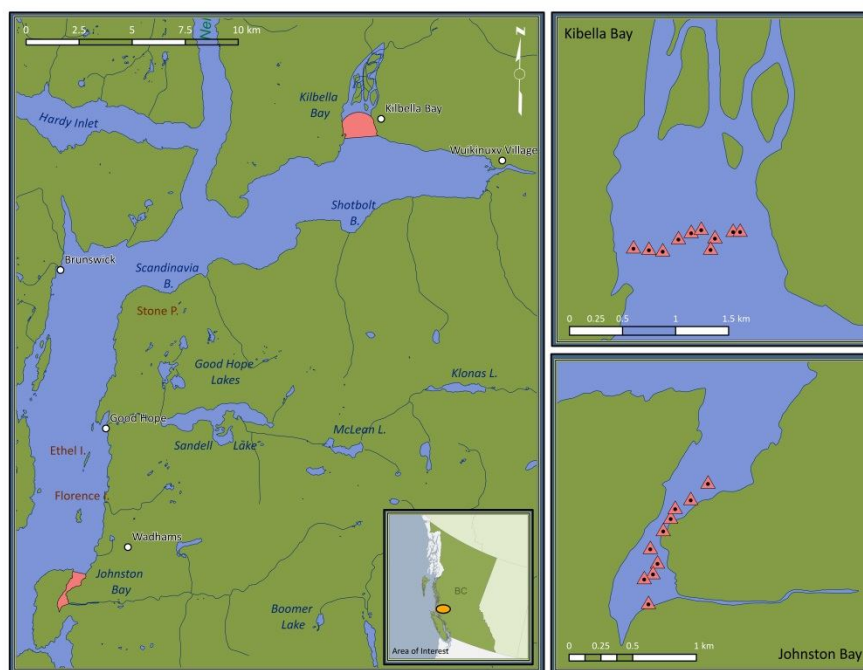


Fig 1. Map of the study area. The left panel depicts the study sites (Kilbella Bay and Johnston Bay) in the context of Rivers Inlet; pink shading depicts the estimated areas of crab habitat within each study site. Right panels show the location of individual traps (after initial depth adjustments).

Sampling was based on protocols developed by Fisheries and Oceans Canada (Dunham *et al.* 2011). Traps were stainless steel, inlet-type, circular with 91.4-cm diameter and closed escape ports. Bait was Pacific herring placed inside 500-ml vented

jars made of plastic and suspended from the centre of the trap's lid. Bait amount was two large or three smaller herring.

Initially, we stratified sampling into three depth categories: deep (66-77 m), mid-depth (31-36 m), and shallow (5-10 m). As fieldwork progressed, however, bycatch of species associated with rocky substrate (urchins, tanner crabs) suggested that the soft-bottom habitats preferred by Dungeness crab were scarce at deep strata and patchy at the mid-depth locations chosen initially. Therefore, during subsequent sessions we adjusted depths and locations to sample the appropriate habitats more consistently (Fig. 2). These adjustments were greater at Johnston Bay, where five days into the study we stopped sampling deep habitats altogether and increased trapping effort at mid-depth strata. Sampling at both sites used 10 traps initially, but trap losses occurred at Kilbella Bay during the study (Fig. 2). Minimum trap spacing was 100 m in deep and mid-depth strata, but reduced to 75 m in the smaller areas containing shallow strata. Traps soaked for approximately 24 hours before sampling.

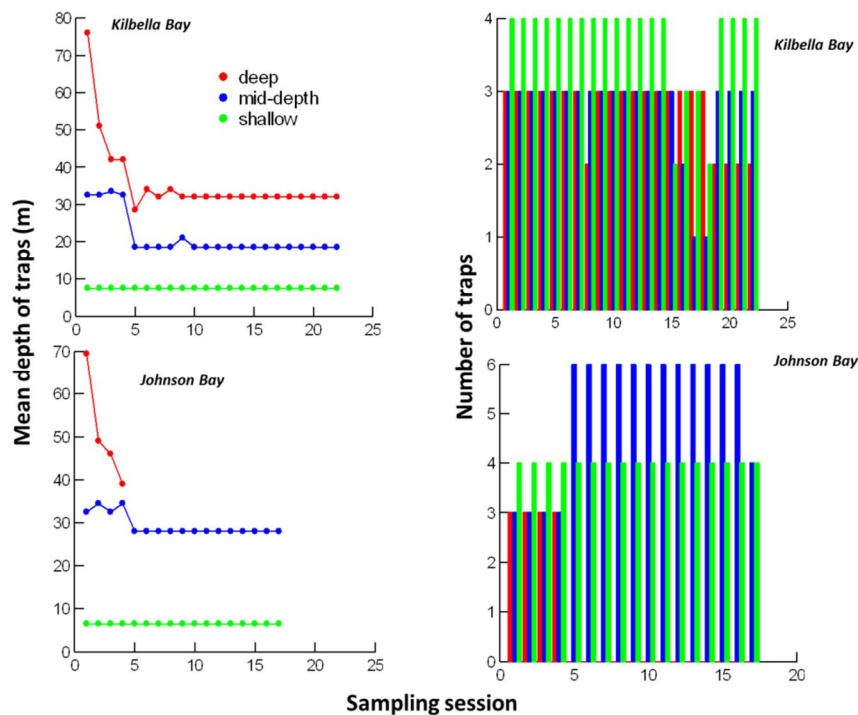


Fig. 2. Mean depth and number of traps by depth category, site and sampling session.

Upon trap retrieval, standard data were collected on each crab's biological characteristics, including sex, shell hardness, injuries and notch-to-notch width (Dunham *et al.* 2011). Most individuals—81.9% of 552 at Johnston Bay, 91.3% of 332 at Kilbella Bay—were tagged with 6-cm-long Floy Tags with double-T anchors (Fig. 3). Most crabs released untagged were small individuals (primarily females) perceived to be particularly vulnerable to physical damage during tagging (see Discussion). Some, however, were not tagged due to equipment failure or other issues¹. Following the advice of personnel from NOAA and the Alaska Department of Fish and Game (Pam Jensen and Janet Rumble pers. comm.), we attached tags through the posterior margin of the epimural suture,

¹The “untagged” category includes at least 6 crabs tagged without a proper record of tag data.

above the third leg from the front (Fig. 3). To reduce the potential for physical damage, we strove to insert the tagging needle partway, only deep enough to secure tag attachment. Crabs were released immediately after data recording (if untagged) or tagging.

Except for the shallow area in Johnston Bay, which is inside a protected cove, vessel drift due to wind and/or tide occurred while we processed crabs on deck. Therefore, most crabs were released at distances away from traps that varied according to marine conditions (see Discussion).



Fig. 3. Dungeness crab with a floy tag about to be released. The tagging gun is visible in lower right.

Mark-recapture analysis

Mark-recapture data were analyzed using closed Huggins mark-recapture models (Huggins 1991) in program MARK (White & Burnham 1999; White *et al.* 2002) to estimate population size for the sampled areas. Analyses explored the effects of depth, sex, carapace width and sampling session on recapture probability. Models were evaluated using information theoretic methods (Burnham & Anderson 1998).

Exploratory analysis was conducted with the POPAN open model (Schwarz & Arnason 1996) in program MARK, which assumes a “superpopulation” of crabs in the surrounding area that have some probability of being sampled during the study. The “superpopulation” may not be present in the sampling area during each sampling occasions. POPAN estimates (1) apparent survival, θ , which depicts the probability that a crab sampled during one session is present in the sampling area during the next session, (2) the probability that a crab from the superpopulation enters the sampling area during the interval between sampling periods, (3) the recapture rate of crabs during sampling, and (4) superpopulation size, \hat{N} .

Results

Our sampling yielded 577 and 339 captures of Dungeness crabs at Johnston Bay and Kilbella Bay, respectively, including 29 tagged individuals recaptured at least once. More males were detected than females and most captures occurred at shallow depths (Figure 4, Table A1 in appendix).

At Johnston Bay, 453 individuals were tagged, including 22 (4.9%) that were recaptured during subsequent sessions. In Kilbella Bay, 303 crabs were marked, of which 7 (2.3%) were recaptured (Fig. 4, Table A1). Additionally, fishers (92% recreational, 8%

Wuikinuxv) reported catching 26 of the crabs we tagged; these fishery-dependent recaptures occurred at both sites (Kilbella Bay 38%, Johnston Bay 62%), after crabs had been at liberty for periods ranging from 5 days to 5 months (Table A2 in appendix).

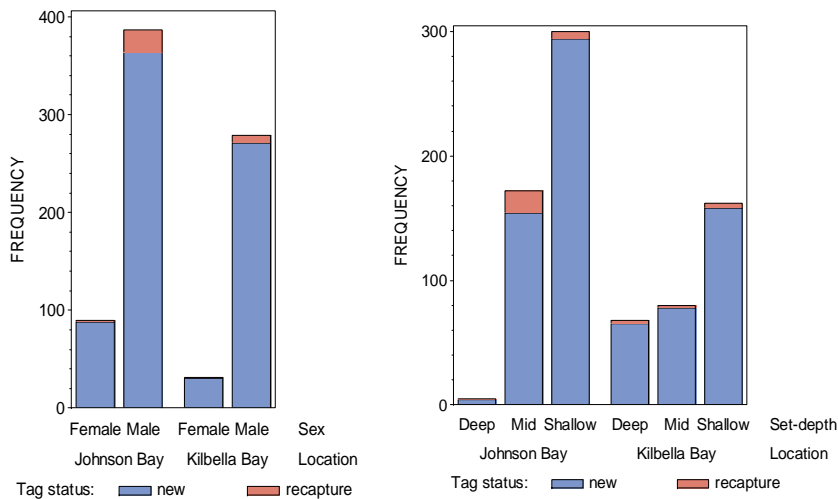


Figure 4: Frequencies of tagged crabs not recaptured (tag status="new") or recaptured, by site, sex and depth.

At Johnston Bay, the number of captures per session tended to decline during the study. At Kilbella Bay, the number of captures was variable with no underlying trend (Fig. A1 in appendix).

CPUE, body size and injury rates

For each depth strata and site combination, we estimated daily catch per unit effort (CPUE), as the sum of crabs caught divided by the sum of traps used. CPUE varied according to site and depth. It was greater at Johnston Bay than at Kilbella Bay, and declined with increasing depth at both sites. The effect of depth, however, was stronger at Johnston Bay (Fig. 5, Table A3 in appendix).

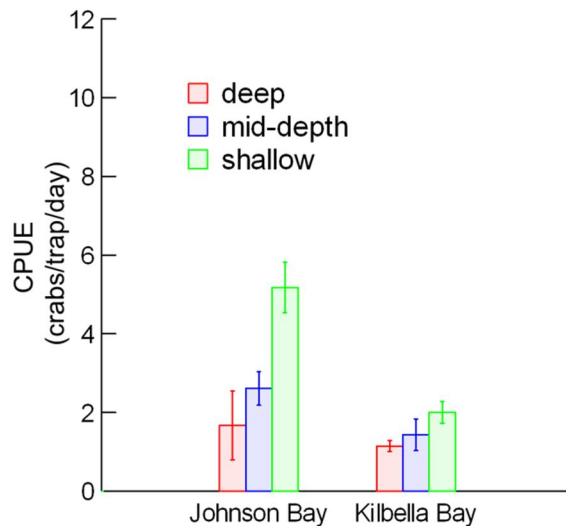


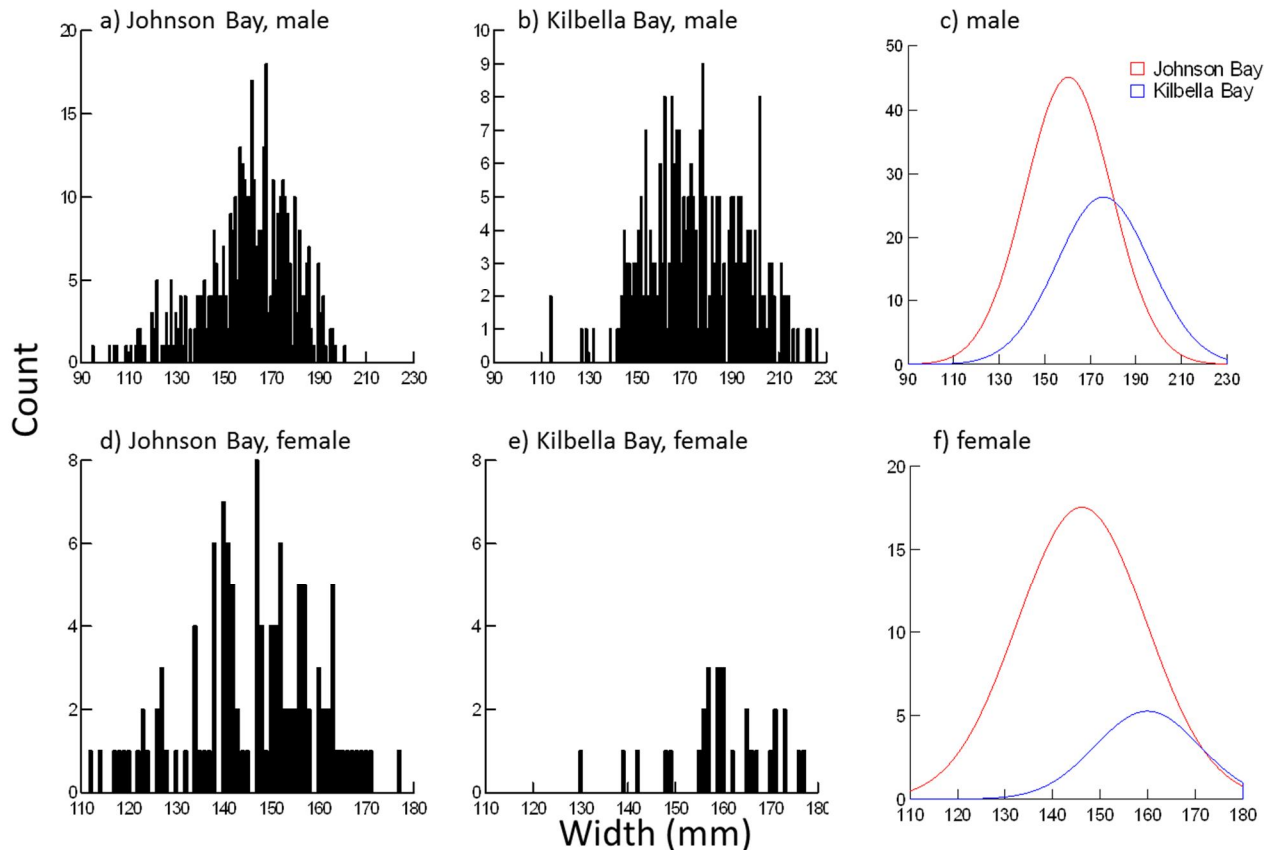
Fig. 4. Catch per unit effort (crabs/trap/day) by study site and depth category. Bars represent means \pm standard errors. Data are pooled for both sexes and include the 29 recaptures of tagged crabs (see Table A1). See Table A3 for ANOVA results.

The size structure of crabs differed between the two sites (Fig. 6; Two-Sample Kolmogorov-Smirnov tests $P < 0.001$). The modal carapace width of both sexes and the

maximum sizes of males were greater at Kilbella Bay than at Johnston Bay. Maximum female size, however, was similar at both sites (Fig. 6).

At Johnston Bay, the proportion of large crabs (i.e., carapace width above modal size) was greater at shallow than at mid-depth strata (Figs. 7a,b; Two-Sample Kolmogorov-Smirnov tests $P < 0.001$). The few crabs caught in deep strata at this site were small, with median carapace widths of 127 mm for males ($n=15$, recaptures excluded) and 119 mm for females ($n=4$, recaptures excluded).

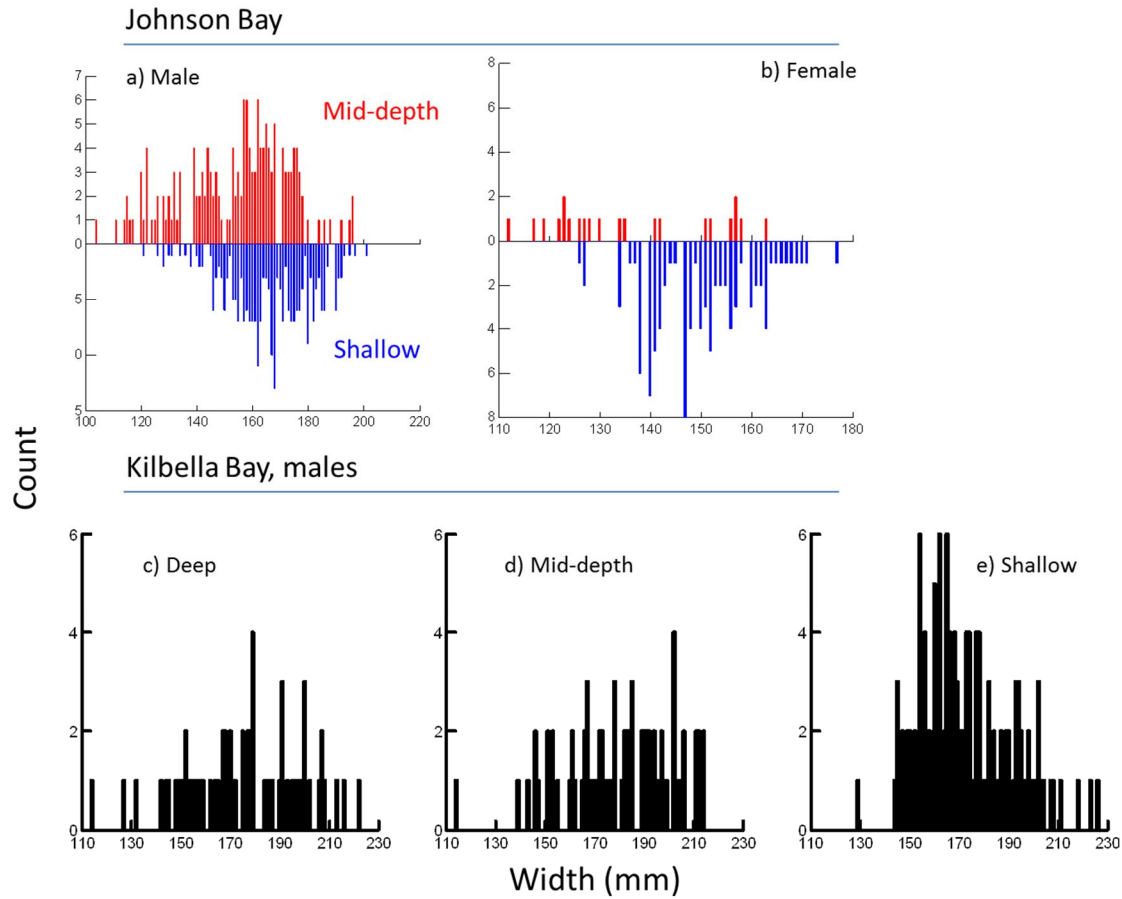
Fig. 6. Frequency distribution (panels a, b, d, e) and normal curves (panels c and f) for notch-to-notch carapace widths of Dungeness crabs, by site and sex. Recaptures are excluded.



For males at Kilbella Bay, the frequency distribution of carapace widths was similar across depths (Fig 7: Pearson Chi-Square=160.46, DF=158, $P=0.43$). At this site almost all females (93%, $N=29$, recaptures excluded) were caught in shallow strata, and therefore depth effects on body size could not be analysed.

The frequency distribution of missing limbs (claws or legs) was similar at both sites (Two-Sample Kolmogorov-Smirnov tests $P=0.944$; Fig. A2 in appendix).

Fig. 7. Frequency distribution for notch-to-notch carapace widths of Dungeness crabs, by site sex, and depth category. (Not shown are site-depth-sex combinations with few data.) Recaptures are excluded.



Mark-recapture population estimation

Johnston Bay

For Johnston Bay, Huggins closed model selection suggested that recapture rates varied by session and depth, with lower rates in shallow areas (Table A4 in appendix, model 1). Sex of crab was supported as a covariate, but only marginally (Table A4; model 2).

Capture probabilities were less than 0.01 for all sessions and followed the general trajectory of captures displayed in Figure A1 (Table A5 in the appendix). The model-averaged estimate of population size was 4740 crabs (3619 males and 1121 female), but uncertainty, as depicted by confidence intervals, is large (Table 1). POPAN models did not achieve convergence, presumably due to low recapture rates and large temporal variation in captures.

Table 1: Model averaged estimates of population size for Johnston Bay from closed models

Sex	mt+1	Estimate	SE	Lower CI	Upper CI	CV
Females	88	1,121	534.1	639	2,025	47.7%
Males	365	3,619	886.8	2,668	4,963	24.5%
Total	453	4,740	1192.4	3,466	6,552	25.2%

Kilbella Bay

For Kilbella Bay, Huggins model selection suggested that capture probabilities varied by session and depth, with deep sets showing higher capture probabilities (Table A6 in appendix). Estimates of capture probability for each session are given in Table A7 (in appendix). The model-averaged estimate of population size was 6855 crabs (6166 males and 689 female), but uncertainty around these estimates is large (Table 2).

Table 2. Model averaged estimates of population size for Kilbella Bay from Huggins closed models

Sex	Marked crabs	Estimate	SE	CI lower bound	CI upper bound	CV
Females	29	689	336.7	383	1,257	48.9%
Males	274	6,166	2565.0	3,714	10,365	41.6%
Total	303	6,855	2872.6	4,115	11,564	41.9%

Discussion

Biological inferences

Our results suggest that Dungeness crab are larger and—as inferred from mark-recapture population estimates—*might* be more abundant at Kilbella Bay than at Johnston Bay. Interestingly, mark-recapture estimates contradicted less rigorous CPUE data suggesting that Dungeness crabs might be more abundant at Johnston Bay than at Kilbella Bay. In spite of their greater rigour, however, mark-recapture estimates had substantial uncertainty and further work with greater recapture rates is needed to evaluate CPUE vs. mark-recapture results. Further, the proportion of untagged crabs was greater at Johnston Bay (18.1%) than at Kilbella Bay (9.7%), which may have biased the mark-recapture estimate towards a lower value at Johnston Bay.

Kilbella Bay is a larger estuary containing more crab habitat and is the terminus for a larger watershed than Johnston Bay (Table 3; Fig. 1) Our preliminary inference that crabs are larger and might be more abundant at Kilbella Bay, therefore, is consistent with recent research at 19 watersheds of the Central Coast concluding that crab abundance increases with estuary size, and that crab size increases with watershed area above the estuary. These patterns appear to be driven by the combined effects of more habitat area in larger estuaries and of greater nutrient subsidies from spawned-out salmon and forest-derived organic matter below larger watersheds (Harding & Reynolds 2014).

Table 3. Watershed area (source: GeoBC) and area of estimated crab habitat (pink shading in Fig. 1) for each study site.

Study site	Watershed area (km ²)	Approx. area of crab habitat (km ²)
Kilbella Bay	676.57	1.61
Johnston Bay	133.08	0.73

During the three-week study period, Dungeness crabs were most abundant at shallow depths, and we found no evidence of increasing crab size at greater depth. Seasonal depth use, however, is essentially unstudied in the Central Coast, whereas work elsewhere

suggests that shifts to deeper strata may occur seasonally (Rasmuson 2013). Accordingly, the sampling of different depth strata should remain a study objective.

Ultimately, Central Coast Nations need to infer exploitation impacts from commercial and recreational fishers on different crab populations. Experimental fishery closures are required to make such inferences. Although a voluntary closure was attempted for Kilbella Bay, this was unsuccessful, as 9 of 24 (38%) sport fishery captures of tagged crab occurred there (Table A2). Clearly, for Central Coast Nations to evaluate fishery impacts rigorously, the support of DFO in legislating experimental fishery closures will be required. Additionally, the spatial coverage of the study would have to expand and include more sites, which would be difficult with existing personnel and resources.

Recommendations for improving mark-recapture population estimates

Low recapture rates limited the precision of estimates and the modelling of variation in capture probabilities, and likely prevented convergence of the POPAN model. Below we list recommendations for increasing recapture rates and improving methodology.

1. *Tag all crabs caught in traps.* The exception may be crabs deemed too small to withstand tagging without physical damage, which requires that a minimum tagging size be standardized through consultation with experienced personnel (e.g., researchers from DFO or NOAA). Critically, this minimum size criterion would have to be used *consistently at all sites*, as mark-recapture estimates would apply only to crabs at or above the size threshold.
2. *Add more traps to increase trap encounter and therefore recapture rates.* This approach may require 2-day sessions rather than a single-day sampling, yet is critical. Through its implementation we would find out fairly quickly if low trap effort relative to population size is the cause of low capture/recapture rates.
3. *Assess trap saturation*, which might limit the proportion of the population that can be sampled per session. Trap saturation could be explored with the current data set by comparing the crabs per trap with other published studies. Many published studies employed a much higher number of traps per session. As a starting point, doubling the number of traps used per site to 20 is likely might substantially increase recapture rates.
4. *Consider other covariates.* Temporal variation was substantial for recapture rates and for the number of crabs capture per session. The use of other covariates, such as bathymetric variables or other factors, might help describe this variation and improve precision. Covariate selection could be informed by published studies and traditional knowledge.
5. *Use drop-video camera to ensure suitable habitat are sampled.* This recommendation applies primarily to deep and mid-depth strata, where suitable habitat appeared patchier than at shallower depths. Part of the unexplained variation in recapture rates likely relates to some traps being set in lower quality (e.g. rocky) habitat. The use of drop video camera (for which we already have equipment and capability) for selecting trap locations at small spatial scales would ensure that only suitable habitats are sampled, thereby reducing unexplained variation or at least allowing for using habitat descriptors as covariates (see #4).

6. *Consider the possible effect of behaviour on recapture probabilities.* Analyses assume no behavioural response by crabs to sampling. A behavioural response occurs if the capture probability of a crab that was tagged changed after capture. Biological mechanisms for a behavioral response include learned trap aversion due to previous negative experience. We lack rigorous data to assess whether learned trap aversion by Dungeness crabs occurs, yet other researchers suggest, anecdotally, that its effects on recapture probability might not be strong (Pam Jensen, NOAA, pers. comm.).

Methodology also may contribute to behavioural effects, for instance, if crabs are released at far distances from traps and therefore are less likely to be recaptured. Indeed, our vessel drifted away from traps before we released crabs. In the future, this potential sampling effect could be accounted by analysing release distance as a covariate. (This would require marking GPS locations of each crab release and relating that to the GPS location of each trap in the array.)

A large-scale behavioural response (population rather than individual level) also would cause low recapture rates since crabs would be less likely to be recaptured. This would cause a positive bias in non-behavioural models.

Behavioural models were indeed tested with some suggestion of support. However, full convergence was not achieved resulting in very large standard errors. A quick search of the literature did not reveal any evidence of behavioural response in other studies. As discussed earlier, it is plausible that the low recapture rates reflected low trap effort relative to the size of the population being sampled.

7. *Consider spatially-explicit models in future analysis (after increasing recapture rates).* Low recapture rates precluded proper evaluation of whether the sampled population was closed. Most crabs detected were new captures each session. These crabs could have always been present in the area but not detected due to relatively low trap density, or could have moved in from other areas. A data set with more recaptures would allow better assessment of marked crab fidelity to the sampling area, which is one component of closure violation. The POPAN model provides a useful method to model closure violation and obtain estimates of superpopulation size.

Spatially explicit mark-recapture methods (Efford 2004; Efford *et al.* 2009; Efford & Fewster 2013) can assess closure violation and also use information about trap location, trap attributes, and sources of density variation within the sampling area. They require data from repeat spatial captures of crabs to model movements and the effective sampling area of traps, but likely are feasible only with a large number of recaptures.

8. *Consider methods for detecting long-term trends in populations.* Monitoring trends from repeated seasonal samplings requires a robust design method that combines estimates from closed models (i.e. the results in this paper) with open models to estimate apparent survival and trend (Pollock *et al.* 1990). For precise estimates, individual crabs need to be redetected across seasons (to estimate apparent survival) (Pradel 1996). The best design for this method is to initially mark as many crabs as possible and then relax the sampling effort in subsequent seasons after a critical number of crabs is marked. This approach can use covariates to help assess factors affecting demographic trends in the various sampling areas (Boulanger *et al.* 2004).

Acknowledgements

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Appendix: additional tables and figures

Table A1: Dungeness crab capture and recapture events by location and sex during fishery-independent sampling.

Location/sex	Tagged	Recaptured once	Recaptured twice	% recaptured
<i>Johnston Bay</i>				
Female	88	2	0	2.3%
Male	365	18	2	5.5%
Total	453	20	2	4.9%
<i>Kilbella Bay</i>				
Female	29	1	0	3.4%
Male	274	6	0	2.2%
Total	303	7	0	2.3%

Table A2. Fishery recaptures of tagged crabs.

Tag	Sex	Carapace width	Date tagged	Date caught	Location	Fishery
120	male	181	2-May-14	17-May-14	Johnston	Wuikinuxv FSC
998	male	148	22-May-14	16-Jul-14	Kilbella	Recreational
67	male	169	1-May-14	25-May-14	Kilbella	Recreational
1014	male	192	20-May-14	25-May-14	Kilbella	Recreational
368	male	164	8-May-14	28-Jul-14	Kilbella	Recreational
613	male	196	21-May-14	28-Jul-14	Kilbella	Recreational
489	male	168	11-May-14	26-Jul-14	Johnston	Recreational
939	male	174	17-May-14	9-Aug-14	Kilbella	Recreational
244	male	174	5-May-14	July	Johnston	Recreational
313	male	180	6-May-14	July	Johnston	Recreational
287	male	179	6-May-14	July	Johnston	Recreational
582	male	171	13-May-14	July	Johnston	Recreational
251	male	159	5-May-14	July	Johnston	Recreational
546	male	167	12-May-14	July	Johnston	Recreational
104	male	190	2-May-14	July	Johnston	Recreational
207	male	186	4-May-14	July	Johnston	Recreational
51	male	191	30-Apr-14	July	Johnston	Recreational
42	male	158	1-May-14	July	Johnston	Recreational
482	male	183	10-May-14	9-Jul-14	Johnston	Recreational
538	male	193	12-May-14	18-Jul-14	Kilbella	Recreational
473	male	164	10-May-14	16-Jul-14	Kilbella	Recreational
260	male	166	5-May-14	25-Aug-14	Johnston	Recreational
411	male	188	8-May-14	25-Aug-14	Johnston	Recreational
96	male	184	2-May-14	25-Aug-14	Johnston	Recreational
324	male	172	7-May-14	9-Aug-14	Kilbella	Recreational
618	male	211	21-May-14	10-Nov-14	Kilbella	Wuikinuxv FSC

Fig. A1: Frequencies of crabs marked or recaptured by site and sampling session.

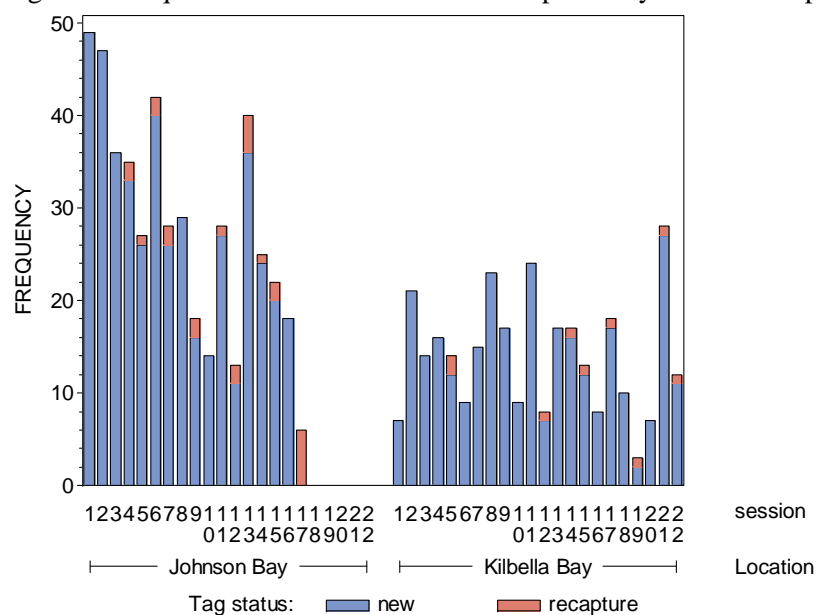


Table A3. ANOVA results for the effects of study site and depth on CPUE. Data were pooled for both sexes and include recaptures of 29 tagged crabs.

Predictor	Type III SS	df	Mean Squares	F-Ratio	p-Value
Depth	69.838	2	34.919	12.676	0.000
Site	47.084	1	47.084	17.092	0.000
Depth X Site	26.963	2	13.482	4.894	0.009
Error	269.958	98	2.755		

Fig. A2. Frequency distribution of number of missing limbs (claws or legs) by site. Sexes are pooled and recaptures excluded.

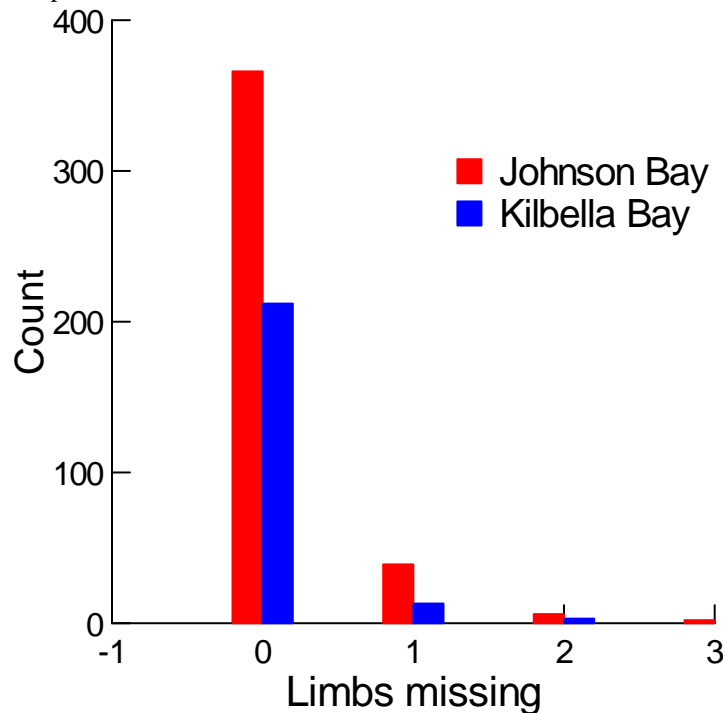


Table A4: Huggins closed model selection for Johnston Bay. AIC_c = sample size adjusted Akaike Information Criterion, ΔAIC_c = the difference in AIC_c between the model and the most supported model, AIC_c weight = w_i , K , the number of model parameters and deviance are given.

No	Capture probability model	AIC_c	ΔAIC_c	w_i	K	Deviance
1	Session+ shallow	2815.25	0.00	0.62	18	2779.17
2	Session+ shallow+sex	2816.81	1.55	0.29	19	2778.71
3	session	2819.01	3.76	0.09	17	2784.93
4	Linear trend (session)	2832.58	17.33	0.00	2	2828.58
5	constant	2877.99	62.74	0.00	1	2875.99
6	sex	2878.84	63.58	0.00	2	2874.84
7	Effort (session)	2879.16	63.91	0.00	2	2875.16
8	Crab length	2879.89	64.63	0.00	2	2875.88
9	Sex+length	2880.36	65.10	0.00	3	2874.36
10	Sex+length+sex*length	2881.53	66.28	0.00	4	2873.53

Table A5: Johnston Bay model averaged session capture probabilities from Huggins Closed models (Table 2)

Session	Estimate	SE	Lower CI	Upper CI
1	0.011	0.003	0.007	0.018
2	0.011	0.003	0.006	0.018
3	0.008	0.002	0.004	0.013
4	0.008	0.002	0.004	0.012
5	0.006	0.002	0.003	0.010
6	0.010	0.002	0.005	0.014
7	0.006	0.002	0.003	0.010
8	0.007	0.002	0.003	0.010
9	0.004	0.001	0.002	0.007
10	0.003	0.001	0.001	0.005
11	0.006	0.002	0.003	0.010
12	0.003	0.001	0.001	0.005
13	0.009	0.002	0.004	0.014
14	0.006	0.002	0.002	0.009
15	0.005	0.002	0.002	0.008

Table A6: Huggins closed model selection for Kilbella Bay. . AICc = sample size adjusted Akaike Information Criterion , $\Delta AICc$ = the difference in AICc between the model and the most supported model , AICc weight = w_i , K, the number of model parameters and deviance are given.

No	Capture probability model	AIC _c	ΔAIC_c	w_i	K	Deviance
1	Session	1955.99	0.00	0.57	22	1911.8
2	Session+deep	1956.58	0.59	0.43	23	1910.4
3	Trap effort (session)	1971.41	15.42	0.00	2	1967.4
4	constant	1974.88	18.89	0.00	1	1972.9
5	deep	1975.46	19.47	0.00	2	1971.5
6	Linear trend (session)	1976.41	20.42	0.00	2	1972.4
7	Sex	1976.73	20.74	0.00	2	1972.7
8	length	1976.81	20.82	0.00	2	1972.8
9	Length+sex+sex*length	1980.64	24.65	0.00	4	1972.6

Table A7. Kilbella Bay capture probabilities from Huggins closed models.

Session	Estimate	SE	LCI	UCI
1	0.001	0.001	0.000	0.002
2	0.003	0.001	0.000	0.006
3	0.002	0.001	0.000	0.004
4	0.002	0.001	0.000	0.005
5	0.002	0.001	0.000	0.004
6	0.001	0.001	0.000	0.003
7	0.002	0.001	0.000	0.004
8	0.003	0.002	0.000	0.006
9	0.003	0.001	0.000	0.005
10	0.001	0.001	0.000	0.003
11	0.004	0.002	0.001	0.007
12	0.001	0.001	0.000	0.002
13	0.003	0.001	0.000	0.005
14	0.003	0.001	0.000	0.005
15	0.002	0.001	0.000	0.004
16	0.001	0.001	0.000	0.002
17	0.003	0.001	0.000	0.005
18	0.002	0.001	0.000	0.003
19	0.000	0.000	0.000	0.001
20	0.001	0.001	0.000	0.002
21	0.004	0.002	0.001	0.008
22	0.002	0.001	0.000	0.004