Considerations for setting minimum legal size for pāua in PAU3A – discussion document

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Background

On the 1st of December 2021, the PAU3A (Kaikōura) fishery was re-opened to pāua fishing for the first time since the earthquake-related fishery closure in November 2016. The re-opening of the pāua fishery was initiated by a proposal to the Minister from the Kaikōura Marine Guardians in May 2021. This proposal advised that the fishery should be re-opened when biological criteria of pāua population recovery have been met and when appropriate management controls were in place to ensure sustainability (Kaikōura Marine Guardians 2021).

Evidence that the biological criteria for pāua population recovery had been met was provided by intertidal and subtidal surveys of pāua abundance in the earthquake fishery closure. These surveys demonstrated an area wide increase in mature pāua biomass and widespread post-earthquake recruitment in the fishery closure (Gerrity 2020; McCowan and Neubauer 2021). The proposal also included a suite of management measures for recreational fishing, including the recommendation that the minimum legal size (MLS) for pāua be set at 130mm. The rationale for increasing the MLS to 130mm (from 125mm pre-earthquake) was to provide additional spawning opportunities for mature pāua as an important safeguard for the productivity as it continues to rebuild (Kaikōura Marine Guardians 2021). This recommendation to increase MLS was based on scientific advice and input from all fisheries stakeholders.

The Minster decided to retain the previously implemented size limit of 125mm for the re-opening. This was due to concerns about the potential for increased incidental fishing mortality of pāua with an increased size limit and to avoid confusion and assist compliance (Fisheries New Zealand 2021a), however no research was cited in support of potentially increased mortality, nor was there discussion about how any of these concerns would significantly outweigh the sustainability benefits derived from an increased MLS.

During the 3-month fishery opening high levels of recreational harvest were observed and the estimated recreational harvest was 35 t (Ministry for Primary Industries 2022), which was seven times larger than the recreational allowance of 5 t. There was also a significant reduction in the abundance of pāua larger than 125mm in the intertidal and shallow subtidal zone detected by surveys designed to monitor recreational harvest from wadable depths (Gerrity, unpublished). This has caused concern among local stakeholders and driven interest in reviewing the management measures implemented during the initial fishery re-opening, including the MLS. Further, Fisheries New Zealand has stated that the MLS for pāua will be reviewed following the initial 3-month re-opening (Fisheries New Zealand 2021b).

This discussion document is intended to be a resource for stakeholders as part of Fisheries New Zealand's MLS review process and provides information about the rationale behind MLS setting, with specific application to pāua (and abalone in a wider context) and the PAU3A fishery.

Minimum legal size in abalone fisheries

Minimum legal size (MLS) is one of the oldest and most widely applied fisheries management tools (Mundy and Haddon 2016). The underlying rationale behind the setting of MLS ranges from historically being used to ensure harvest of animals of a marketable size, to control the amount of harvest, and to protect the spawning biomass (Hancock 1992; Mundy and Haddon 2016). It is now commonly accepted that the primary rationale behind setting MLS is to provide protection for immature animals or some minimum spawning biomass (Stewart 2008; Mayfield et al 2012). In other words MLS enables animals to reach maturity and spawn for a number of years to sustain the fishery before they can be harvested and removed from the population (Goodyear 1993; Ministry of Fisheries 2009).

For abalone, MLS setting has traditionally been discussed in terms of size at maturity plus two years (commonly called the "2-year rule"). This concept was born out of the Tasmanian abalone fishery, and despite having no proven reason for why this should be sustainable, it is widely discussed and adopted in the management of other abalone fisheries (Helidoniotis and Haddon 2014). This vague rational seems to be common to abalone fisheries management where MLS is often set with no formal basis (Haddon and Mundy 2016).

For pāua fisheries specifically, the MLS was first set at 5 inches (127mm) under the General Fisheries Regulations 1971. There is no documented reason for this size, although it was perhaps set as the minimum size of pāua that was marketable. When the metric conversion was applied, it was lowered to 125mm, presumably due to administrative rounding rather than any scientific reasoning. The first scientific analyses of the appropriateness MLS by Sainsbury (1982) used yield-per-recruit analyses based on growth and size at maturity data from Banks Peninsular and Kaikōura. This determined that the current MLS (127mm at the time) was appropriate to optimise the yield for most pāua stocks around New Zealand (Sainsbury 1982). Coincidentally, based on best estimates, 125mm is also close to the length at maturity plus two years growth for many pāua stocks around New Zealand, hence the "2-year rule" is frequently but erroneously used justification for the setting of MLS in pāua.

Regardless of the underlying basis for MLS setting, whether it be yield-per-recruit analyses or the “2-year rule”, there are two biological parameters that are critical when considering the appropriateness of an MLS. These are the size at maturity and growth rate (or maximum length) (McShane and Naylor 1995; Naylor and Andrew 2000; Haddon and Mundy 2016).

Demographic variability and MLS in abalone fisheries

It is well documented that pāua populations (and abalone populations generally) exhibit great variability in both growth and length at maturity at different spatial scales (McShane et al 1994; Naylor et al 2006; Mayfield et al 2012). Naylor et al (2006) found that growth rates varied significantly between pāua populations from 30 locations around New Zealand, and that latitude (more specifically sea surface temperature) was strongly associated with growth rates, with pāua from cooler waters (e.g., Stewart Island) growing faster and reaching larger maximum lengths than pāua from warmer waters (e.g., Taranaki) which grew slower and reached smaller maximum lengths (Naylor et al 2006). Length at maturity was shown to have the same general pattern as growth rates, with pāua from more northern waters reaching maturity at smaller sizes than cooler waters (Naylor et al 2006).

Growth in pāua is complex however and is influenced by other factors such as wave exposure, habitat type and food availability (McShane et al 1994; McShane and Naylor 1995). This means that demographic variability can be observed at small spatial scales (100s of metres), e.g., between headlands and bays (McShane et al 1994). So while there is a general pattern of pāua growth rates and maximum size increasing with decreasing water temperatures, fast and slow growing populations can be found in close proximity all around New Zealand due to the other factors that can influence growth (McShane et al 1994).

The consequence of variability in growth rates and length at maturity at different spatial scales around New Zealand is that a single size limit of 125mm can be too small to adequately protect the spawning biomass required for sustainability in areas where pāua have larger length at maturity and faster growth rates. In these areas, an insufficient proportion of the spawning biomass is protected which can result in localised depletion and recruitment overfishing leading to population collapse (Prince 2003; Ministry of Fisheries 2009; Haddon and Helidoniotis 2014; Haddon and Mundy 2016). Conversely, 125mm will be too large in areas where length at maturity is smaller and growth rates and maximum size are lower and most pāua will never reach MLS despite having had the opportunity to reproduce for many seasons, thus limiting utilization of the fishery (Ministry of Fisheries 2009)

This demographic variability in pāua populations (and abalone populations generally) has been cited as one of the primary reasons for the mismanagement of abalone stocks globally

(Prince 2003; Prince et al 2008). With specific regard to pāua, this issue has been recognised with respect to managing āaua stocks nationally with one MLS for decades (Sainsbury 1982; McShane et al 1994; Naylor and Andrew 2000). A small step was taken to remedy this issue in 2009 when the MLS for pāua in the Taranaki region was lowered to 85mm to reflect the lower length at maturity, slower growth rate, and lower maximum size of pāua in this region relative to others (Naylor and Andrew 2000; Ministry of Fisheries 2009). Despite this precedent supporting the underlying rationale and potential for implementation of variable MLS across different regions in New Zealand, it has not been applied elsewhere. Further, despite the logic underlying of lowering the size limit in Taranaki being equally applicable to raising the size limit in faster growing southern areas, this has never been considered.

Hilborn (2009) undertook an exercise using yield-per-recruit modelling based on demographic data for pāua from Naylor et al (2003) to illustrate how different size limits could be applied to maximise the yield from populations of different biological characteristics (i.e., the same process applied to justify an MLS of 127mm in Sainsbury 1982). This illustrated that variable MLS applied to different areas would be required to maximise the yield from the fishery, and recommended MLS of up to 147mm in the fastest growing areas under certain scenarios (Hilborn 2009). This analysis is in keeping with other sources that suggest that the only way to effectively manage abalone fisheries with complex and variable demographics is to reduce the scale of management (including MLS) (Naylor and Andrew 2000; Prince 2003; Prince et al 2008).

Industry implementation of increased MHS

The importance of managing pāua fisheries at scales that reflect their demographic variability has long been recognised within the commercial pāua industry with the implementation of commercial minimum harvest sizes (MHS). MHS are size limits that are agreed upon by regional management bodies (PāuaMACs), and formalised in their Annual Operating Plans, or in some cases in Ministerially approved Fisheries Plans. MHS are currently implemented in all pāua Quota Management Areas (QMAs) except PAU1 in the north of the North Island. Up to five MHS are implemented in some QMAs in recognition of local scale variability in pāua demographics within specific regions. MHS generally increase in size with decreasing latitudes (with cooler sea temperatures), which recognises and affirms the findings of Naylor et al (2006) discussed above. The MHS implemented in pāua QMAs around New Zealand are shown in Figure 1.

MHS has also been used as a tool intended to increase the rate of stock recovery in fisheries where stocks have been depleted. One example of this in in PAU5B (Stewart Island) where concerns about the status of the stocks in the early 2000s lead to a quota cut and implementation of increased MHS to increase the protection of the spawning biomass to accelerate recruitment and population recovery. Since 2010 the MHS in PAU5B has incrementally increased to 140mm. This has contributed to recovery of the stocks to the point where the Minister recommended a TACC increase in 2020 which is the first time this has ever happened for a pāua stock.

Pāua QMA	Industry implemented MHS (mm)
PAU2 (Wairarapa)	125, 128
PAU7 (Marlborough)	125, 128, 131, 135, 145
PAU3A (Kaikōura)	130, 135
PAU3B (Canterbury)	125, 127, 130
PAU4 (Chatham Islands)	127, 130, 135
PAU5A (Fiordland)	125, 130
PAU5D (Otago)	125, 127, 130
PAU5B (Stewart Island)	140

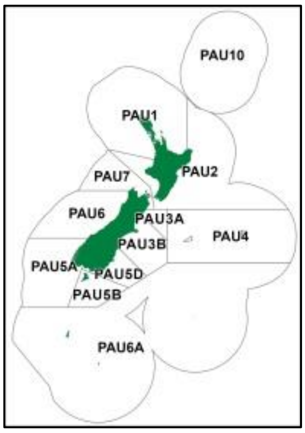

Figure 1: Table showing the MHS implemented in different pāua Quota Management Areas (QMAs), listed in approximate geographic location from north to south. Adjoining map shows location of pāua QMAs.

Variable MLS to reflect the biology of local populations are also implemented in the Tasmanian abalone fishery where eight different MLS (referred to locally as legal minimum length or LML) are applied across different regions (Little 2021). The Tasmanian fishery also has a history of incrementally increasing LML as a response to combat continued fishery declines (Bradshaw 2020). This pattern of decline has seen a progression to the "3-year rule" from the "2-year rule" described above (Little 2021). This shift was supported by analyses by Haddon and Mundy (2016) who used yield-per-recruit modelling to show the proportions of biomass that would be protected by different LML based on different biological parameters. They use an example showing that when a LML of 140mm and a harvest rate of 0.4 (the proportion of LML+ abalone harvested), leaves 55% more mature abalone each year than a LML of 130mm. They also performed simulation analyses to show what proportion of abalone would be above LML after 1, 2 and 3 years post maturity to assess the suitability of the MLS in different zones. These analyses illustrated that the maturity plus 3-year rule is sufficiently protecting the spawning biomass of local populations, whereas the previous 2-year rule could protect spawning biomass, but leave faster growing populations open to serial depletion (Haddon and Mundy 2016).

The general trend of increasing MLS to improve fisheries sustainability is also justified due to some of the biases that are associated with how growth data is collected which is then used to support MLS setting (whether through yield-per-recruit analyses or "2/3-year rule" application). This is because a lot of the tag recapture and length at maturity sample collection come from areas that are favourable to research, rather than being representative of the fishery itself. These tend to be sheltered areas, with high densities of abalone available for data collection. However, these site characteristics also lend themselves to slower growth and potentially lower length at maturity. Further, for growth studies, the tagging process itself may slow growth leading to underestimated growth rates. This mean that MLS set off the basis of this data are likely to be set or justified at a size that is too low (Prince 2003; McCowan 2022). This also supports the use of length-frequency data (and maximum length) as a proxy for growth rates in examining spatial variability in pāua populations in the context of MLS setting (discussed in more detail later).

Discussions around the appropriate MLS can be difficult because it is yet to be conclusively shown what proportion of the mature biomass is required to be protected for sustainability (Haddon and Helidoniotis 2014). Given the discussed uncertainties associated with appropriate MLS setting based on growth and length at maturity data (and modelling analyses) (Naylor and Andrew 2000), it is increasingly becoming accepted that in places where there is an established history of industry management and data uncertainty, following industry practices is often the best approach to management (Bedford et al 2013), and anecdotal reports of positive outcomes from increasing MHS are often seen as enough to suggest benefits and justify their implementation (Prince et al 2008).

Considerations for MLS setting in PAU3A

There are well documented issues arising out of managing the pāua fishery with one MLS of 125mm discussed above. Despite these issues, management and regulation has been slow to adapt, with the one exception of one regionally different MLS in Taranaki. The re-opening of the PAU3A fishery required regulatory change that had the opportunity to change the MLS in this region to reflect local pāua population biology to ensure sustainability of this rebuilding fishery. While this was not implemented in the initial re-opening, there is opportunity for this to be re-considered as part of Fisheries New Zealand's review of the MLS to be undertaken before future re-opening of the fishery (Fisheries New Zealand 2021b).

There is a limited amount of biological data from the PAU3A that could be used to inform MLS setting in the PAU3A using 'traditional' methods such as yield-per-recruit analyses or an application of the "2/3-year rule". There is a small amount of growth data (e.g., Poore 1972b; Pirker 1992), however this data is very site specific so should not be applied to the wider area (discussed in Naylor and Andrew 2000), and it may be subject to conditions leading to slower growth biases discussed above.

In this situation where appropriate growth and length at maturity is lacking, it is widely acknowledged that length-frequency or maximum observable size of pāua can be used as a guide to inform regional MLS (McShane et al 1994; Naylor and Andrew 2000; Haddon and Helidoniotis 2014) as differences in growth rates have been associated with maximum size

(McShane and Naylor 1995). In other words, a larger MHS is likely to be more appropriate in areas with larger pāua.

Information about the length-frequency of commercial catch has been collected since 1989 and the Pāua Industry Council has overseen the collection of this data since 2006. The program requires commercial harvesters to assign one ‘bin’ of pāua per fishing event to be measured and is traceable to the scale of statistical areas (areas of 1-10s of km at which commercial fishing effort is reported) (Cooper 2021). This data is routinely analysed to assess the status of the pāua fisheries and is an important data input for period stock assessments by Fisheries New Zealand. This means there is a huge amount of length-frequency data available to guide decision making about MLS at QMA and statistical area scales.

Figure 2 below shows a summary of the pāua length-frequency data collected at the QMA level from the catch sampling program in the 2015-2016 fishing season (the last full season where data had been collected from all QMAs before the earthquake). This figure shows the cumulative frequency (%) of all pāua measured from each QMA over the 2015-2016 fishing season to illustrate overall differences in the sizes of pāua harvested from the different QMAs. For the purpose of this discussion document, data for PAU3 (as it was at the time of data collection) has been split into PAU3A and PAU3B (as they now exist with the QMA sub-division) to illustrate within QMA size differences across these new sub-QMAs.

Figure 2 illustrates the notable difference in length-frequency profile and overall size of pāua being harvested from different QMAs (pāua from QMAs are smaller to larger moving left to right). This shows that pāua landed commercially in the PAU3A fishery immediately before the earthquake are approximately the average size of pāua landed commercially in New Zealand relative to other QMAs. It is also interesting to note that they are significantly larger than pāua in what is now PAU3B. The differences in sizes of pāua harvested from each QMA in Figure 2 are generally reflective of the differences in increased MHS that are implemented commercially in each QMA (see Figure 1), although the with QMA variation (leading to multiple MHS) cannot be displayed here.

Consideration of this data and the general understanding of the benefits of increased MHS to recognise the regionally variable biology of pāua populations lead PāuaMAC3 to implement an increased MHS of at least 130mm with the re-opening of PAU3A in December 2021 (PāuaMAC3 2021). Further, two different MHS of 130mm and 135mm were implemented in PAU3A to reflect the demographic variability of pāua populations within the QMA. This was applied after analyses of data collected during post-earthquake pāua monitoring surveys (from McCowan and Neubauer 2020) across four ‘zones’ established to implement industry management initiatives (e.g., catch spreading and MHS) (McCowan 2021) (Figure 3 and Figure 4).

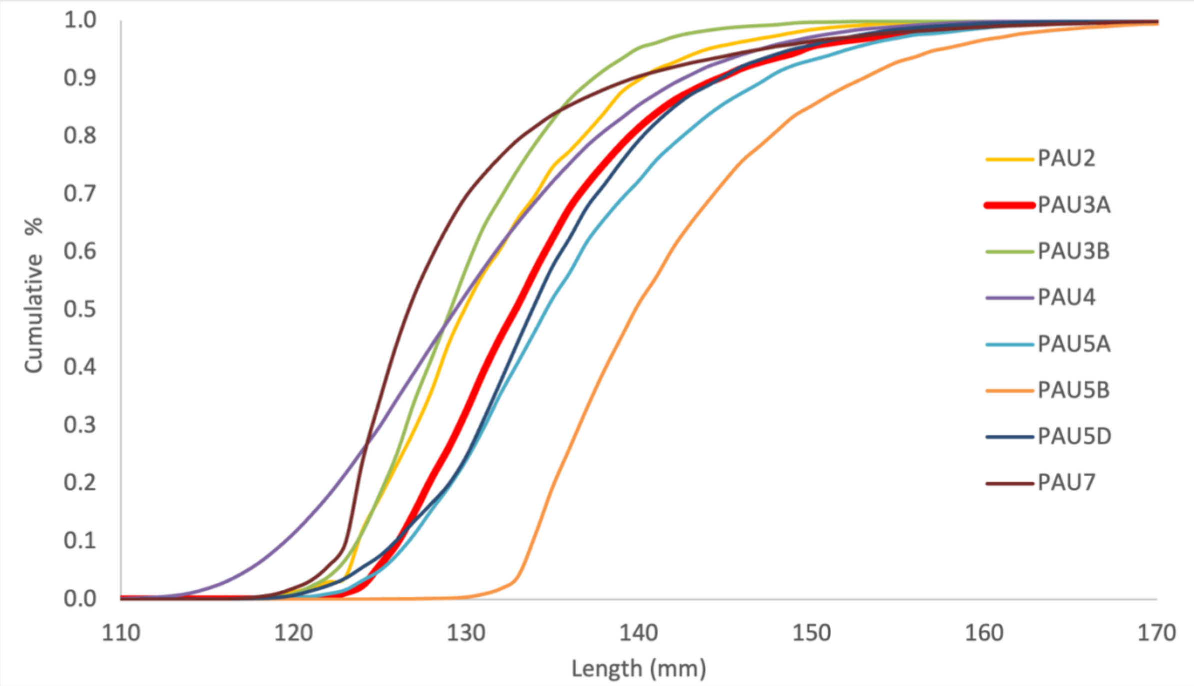

Figure 2: Cumulative length-frequency of all pāua measured in each from the commercial catch sampling program for the 2015-2016 season (immediately pre-earthquake). Note that PAU3 data is split into PAU3A and PAU3B for the purpose of this discussion document.

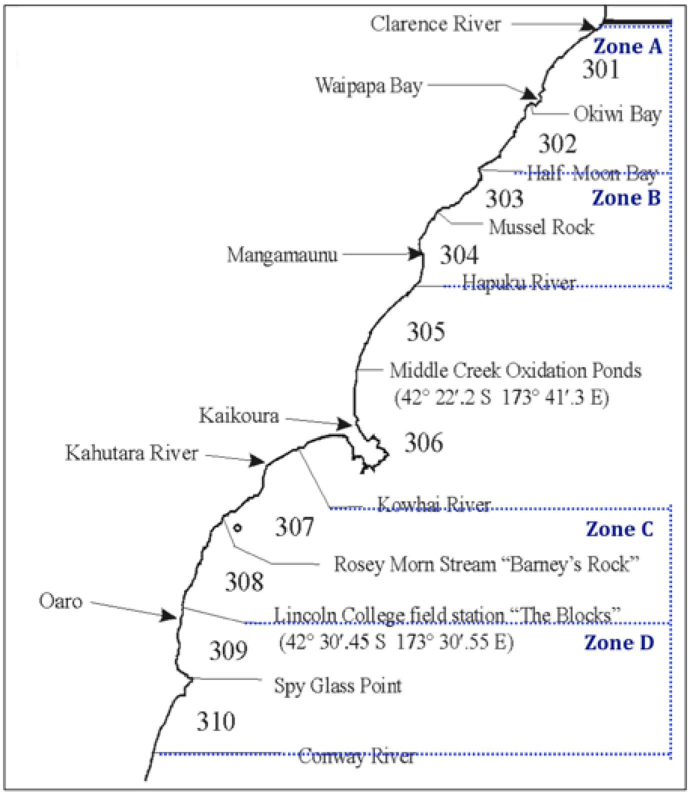

Figure 3: Zones used for implementation of PāuaMAC3 management initiatives (from McCowan 2021).

Figure 4 illustrates observable differences in pāua population size structure between management zones, with pāua from PAU3B and PAU3C being relatively smaller compared to those from PAU3A and PAU3D (note that the terminology used here is to describe PāuaMAC3 management zones in Figure 3, not the newly established wider QMAs). This analysis supported the implementation MHS of 130mm on zones PAU3B and PAU3D and 135mm in PAU3A and PAU3D (PāuaMAC3 2021).

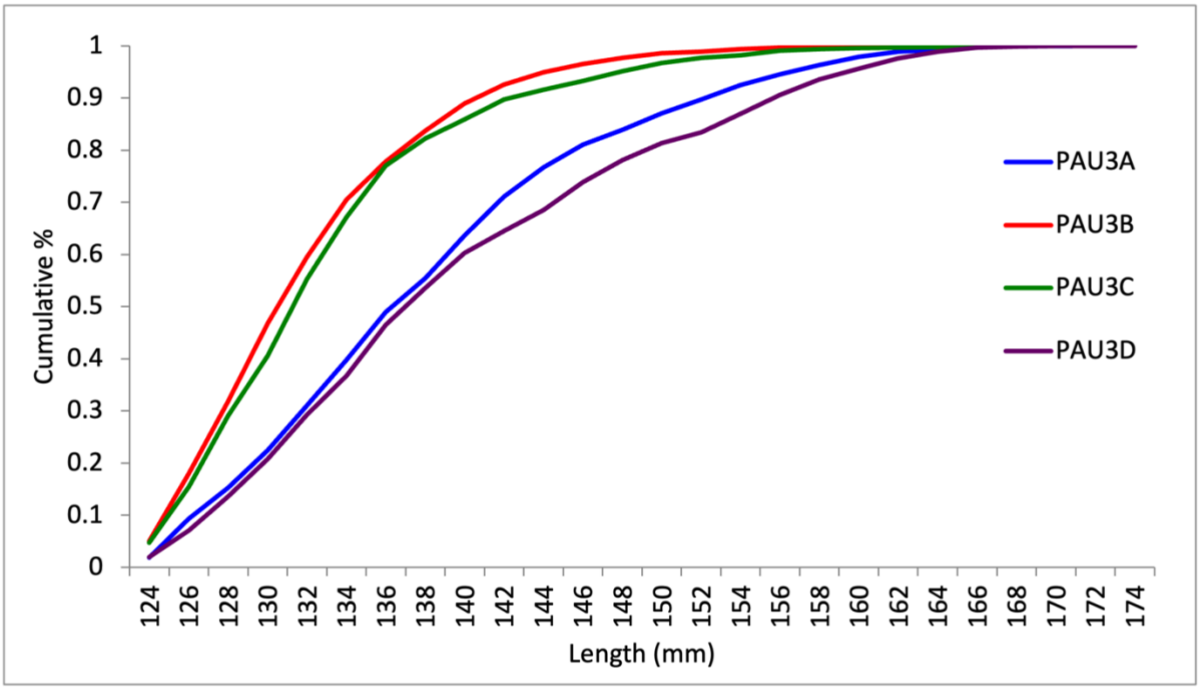

Figure 4: Cumulative length-frequency for all pāua above minimum legal size (125mm) measured in each PāuaMAC3 management zones from all sites surveyed in McCowan and Neubauer 2022. Note terminology PAU3A – PAU3D reflects PāuaMAC3 management zone within the PAU3A QMA, not the wider QMA.

It is generally agreed that there is no reliable means of determining what MLS is appropriate for a specific abalone fishery (Haddon and Mundy 2016), however the above demonstrates how analyses of available data on length-frequency of pāua from different areas can guide the setting of MHS in the commercial context. It has also been stated that in fisheries where there is an established history of industry management and data uncertainty, that following industry practices is often the best approach to management (Bedford et al 2013). Further, larger MLS is recommended when there is a lack of data certainty, to protect all breeding stocks within a wider population (Prince 2003), especially in populations that are stressed or rebuilding (Haddon and Mundy 2016) which is the case for the PAU3A fishery. This is in keeping with the PAU3 Fisheries Plan which has implemented adaptive management initiatives to support a precautionary approach to re-opening, which includes an increased MHS (PāuaMAC3 2021). The value of industry fishing at an increased MHS is undermined when other sectors fish at lower sizes (Prince 2003), which is the case in PAU3A where there is very high recreational fishing pressure. Having alignment between MLS and MHS creates better stakeholder unity and engagement of other beneficial management initiatives moving forward. A shift towards a larger MLS in PAU3A is also supported by results from the recent recreational survey which reported that most of the pāua taken were over 130mm (Ministry for Primary Industries 2022). These are all considerations which favour the increase of the MLS in PAU3A.

The most commonly raised concern used to oppose increasing MLS in abalone is that it increases pressure on the fastest growing populations leading to localised depletion of these areas, and can effectively exclude people from slower growing parts of the fishery (Haddon and Halidoniotis 2014; Haddon and Mundy 2016). It is interesting to note that this was not raised as a concern by those who opposed increasing the MLS in PAU3A with the December 2021 re-opening (Fisheries New Zealand 2021a). This potential consequence means that increasing MHS should also be balanced with decreasing catch (Haddon and Helidoniotis 2014), which has already been undertaken in PAU3A with a reduction in the recreational bag limit from 6 to 5, and a halving of the historic TACC.

One of the stated reasons for not increasing the MLS with the initial re-opening of the fishery was concern about increased incidental mortality of returned undersized pāua, although is no scientific basis to support this. Gerring et al (2003) note low levels of incidental mortality associated with commercial harvest but no comments are made with how this might change with changing harvest sizes. If this was a valid concern it would have been considered within this paper assessing the commercial fishery where MHS varies through most QMAs (Gerring et al 2003).

The other stated reason for not increasing the MLS was due to complications with compliance and enforcement of different size limits between regions and within the same QMA. This has been successfully managed in the implementation of the reduced MLS in the Taranaki pāua fishery, so there is a model for how compliance can be managed in this situation. In the case of monitoring commercial catches with increased MLS, the transition to electronic reporting and GPS location of catches will alleviate difficulties with enforcement, as there are constant geo-referenced records of where harvesters are, and where catch has come from. It is worth noting that the original re-opening proposal from the Kaikōura Marine Guardians recommended the regulatory requirement to use an approved harvest tool for pāua in PAU3A for recreational fishing. This would have a length-specific measurement on it to aid compliance, and compulsory use of the tool would also help to alleviate any concerns around incidental mortality. Finally, in a situation with competing considerations such as this, reasons against increasing MLS must be shown to be important enough outweigh the sustainability benefits to the fishery derived from increasing MLS.

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