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Small research and development activity

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Research Institute for Fisheries Enhancement and Conservation	RIFEC
Visual Implant Elastomer tag	VIE

2 Acknowledgments

I thank Dr Fayakun Satria of RCFMC and the MMAF staff assigned to the lobster restocking program for their cooperation and good humour in the face of a very challenging project. Although my role in the restocking program was very minor, the Indonesian team was very respectful of my part and made me feel a valued member of the team, for which I am grateful.

Thanks also to the ACIAR Indonesian team: Mirah, Wina and Yudhie for their integral support, critical to the project's success.

I gratefully acknowledge the support of MADC staff associates of the ACIAR FIS/2014/059 project, Samsul, Bayu and Dayat for support of the tagging training and for representing our lobster aquaculture project at restocking project meetings.

3 Executive summary

The Indonesian Ministry of Marine Affairs and Fisheries initiated a restocking program for marine lobsters in June 2015 to rebuild and enhance lobster populations in Indonesia for the benefit of the fishing industry.

Before initiating the lobster restocking program, AMAFRAD requested assistance from ACIAR for support, particularly in the area of tagging, which was deemed necessary as a mechanism for assessing the effectiveness of the program. Subsequently, ACIAR established the SRA reported herein, with the aim of providing scientific and technical support, primarily for the tagging activities.

Four tag types were considered, reduced to three on basis of cost and practicality. The three tag types were t-bar anchor tags, polystreamer tags and visual implant elastomer (VIE) tags. Training of the restocking team personnel in the application of tags to lobsters was conducted in Lombok. The training exercise also enabled the three tag types to be assessed in regard to lobster mortality due to tagging and the retention of the tags over subsequent weeks. The t-bar anchor tag was chosen as the preferred tag due to its high visibility, low cost, ease of application, good retention and relatively low post-tagging mortality. Field tagging and restocking of lobsters began in December 2015 and by end of January 2016, around 8,000 *P. homarus* lobsters had been tagged and restocked to two sites - Trenggalek Prigi and Pangandaran. Both sites had also been enhanced by the deployment of artificial lobster houses.

The provision of support by ACIAR to the Indonesian lobster restocking program was worthwhile as it provided specific advice and support of tagging, that was subsequently employed with success in the field.

It's too early to gauge the success of the lobster restocking program. It may take some years before any enhancement of lobster populations is evident.

4 Introduction

The Indonesian rock lobster fishery is spatially and taxonomically diverse, with at least six species fished commercially across the entire 55,000 km of coastal habitats. Despite the significant expanse, the production is relatively small at an average of 7,200 tonnes per annum. To meet both growing domestic and export demand, there is a desire to increase production. The Ministry for Marine Affairs and Fisheries recently introduced a number of new regulations and initiatives that aim to enhance fisheries production. For lobsters these include a minimum legal size and restocking. The proposed restocking program is the subject of this SRA.

The proposed lobster restocking is large scale and ambitious, and the responsible agency sought expert support to improve chances for success. Dr Fayakun Satria from the Research Institute for Fish Enhancement and Conservation (RIFEC) was appointed to lead the lobster restocking program in June 2015. Dr Fayakun approached ACIAR to request assistance and was directed to Dr Clive Jones, who was already leading an ACIAR research project on lobster aquaculture in Indonesia (FIS/2014/059 'Expanding spiny lobster farming in Indonesia'). Initial communication between them indicated that support could be provided in the technical aspects of tagging lobsters and more broadly in lobster biology and management.

The Indonesian Ministry of Marine Affairs and Fisheries assembled a team through the Agency for Marine Affairs and Fisheries Research and Development (AMAFRAD) who tasked its Research Centre for Fisheries Management and Conservation to lead the program. The project involved several institutions including Directorate of Coastal and Small Island (KP3K), Directorate of Fisheries Aquaculture (DJPB) Research and Development Agency, and various Provincial and District Government Fisheries Centres.

The purpose of the SRA was to provide advice on tag type and training in tagging of lobsters for scientists in the lobster restocking team. Tagging of restocked lobsters was recommended as an essential element to assess the effectiveness of the restocking program.

5 Objectives and Terms of Reference

The objective of the SRA was to:

- Provide advice on tag types and application of tags to enable an informed decision on the best tag type
- Provide training in tagging of lobsters
- Assess the post-tagging mortality of lobsters and retention rates of tags

- Provide other advice as required in support of the capture and restocking of lobsters

The SRA was part of a larger body of work aimed at restocking.These objectives were delivered within the context of the Indonesian restocking program's following terms of reference. Specifically this SRA provided direct support for activities five and six, and indirect support for the other objectives:

1. Ecological assessment and pre-survey
    a) Collect data and information on habitat and lobster resources in selected sites for a baseline (before restock): Pangandaran, Pacitan, Prigi, Popoh, Mandeh, Simeulue, Ujung kulon, Tabanan, Kangean (sites subject to change)
    b) Collect data and information related to infrastructure i.e the availability of tanks/floating cages
    c) Establish through surveys readiness of local government and local community to accept the rehabilitation and restocking program
    d) Survey on availability of lobster juvenile/seed (size 25 gram +) in Lombok
2. Provision of artificial reefs (to be made from concrete block) to be deployed where the coral cover is less than 40%, to provide for lobster shelter
3. Provision of Lobster (juvenile):
    a) Lobster juveniles minimum size of 25 gram will be provided by KP3K and DJPB from Lombok and transported to selected sites
4. Intermediate culture
    a) Conduct intermediate culture (grow out) in selected sites with tank facilities before restock
5. Tagging
    a) design tagging program through trial of current tagging methods, and up-skilling of local scientists
    b) Tag juvenile lobster
6. Restocking
    a) Select one site to become a primary site for restocking,
    b) Conduct restocking of both tagged and untagged lobster
7. Social and Economic census
    a) Conduct social and economic studies at selected sites
8. Monitoring and evaluation
    a) Conduct regular monitoring of selected sites

6 Summary of Project Activities

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A preliminary meeting with the restocking program team was held on 24 July 2015 in Jakarta at which Dr Jones outlined tagging options and discussed the challenges of the proposed restocking. Four tag types were introduced: micro wire tags, t-bar anchor tags, polystreamer tags and visual implant elastomer (VIE) tags. Micro wire tags were dismissed as an option due to their expense and technical requirements.

On August 19 a tagging training exercise was held at the Marine Aquaculture Development Centre at Gerupuk Lombok to provide practical demonstration of the techniques for tagging with three tag types. This exercise also provided opportunity to monitor the tagged lobsters of various sizes to provide further assessment of the best tag and lobster size for the restocking program.

Post-tagging mortality was greatest for the polystreamer and least for the VIE. The t-bar anchor tag was considered the best option based on ease of application, high visibility and moderate post-tagging mortality. Lobsters of around 50g size were chosen as the most effective for the restocking program.

Field tagging and restocking of lobsters began in December 2015 and by end of January 2016, around 8,000 *P. homarus* lobsters had been tagged and restocked to two sites - Trenggalek Prigi and Pangandaran. Both sites had also been enhanced by the deployment of artificial lobster houses.

The purpose of this SRA was to provide support to the Indonesian agencies and scientists tasked with the restocking program. The methodology applied by Dr Jones was in the form of advice on matters pertaining to the tagging of lobsters, measurement of tag retention and tagging mortality. A specific tagging training exercise was performed to provide practical demonstration of tag types and their application to lobsters of various size. Advice was also provided to the tagging program personnel on the on-growing of wild caught puerulus lobsters to achieve lobsters of around 25g deemed sufficiently robust for tagging. However, the program leadership decided to focus on wild caught lobsters from restocking, and no culture of lobsters took place.

7 Evaluation of tagging

7.1 Assessment of tag type

In considering the effectiveness and procedures for tagging of lobsters, Dr Jones liaised with associates in the USA where many lobster tagging projects have been implemented. They concurred with Dr Jones that there were four viable options for tagging lobsters:

- Visible T-bar anchor tags
- Poly streamer tags
- Visual implant elastomer (VIE) tags
- Encoded micro-wire tags

Although the availability and application of these tags was well established and understood, the USA associates warned of the challenges of large scale restocking. Evidence from a recent review (Green*, et al.*, 2013) is that lobster restocking programs invariably fail. A series of published papers were reviewed to provide greater insights, comprising (Behringer*, et al.*, 2009; Frisch, Hobbs, 2006; Goni*, et al.*, 2010; Green*, et al.*, 2013; Jensen*, et al.*, 1994; Jerry*, et al.*, 2001; Linnane, Mercer, 1998; Linnane*, et al.*, 2005; Meynecke*, et al.*, 2015; Ochwada-Doyle*, et al.*, 2012; Sharp*, et al.*, 2000; Smith*, et al.*, 2001).

In addition to evaluation of the tag type, the Indonesian program faced the challenge of supply of lobsters for restocking. The lobster fishery throughout Indonesia is in poor condition, and there has been falling catch over many years and a lack of baseline population data. Restocking relies on a supply of lobsters either from existing populations or from on-growing of seed. Although advice was provided on the resources required and methods involved in on-growing seed lobsters to generate large juveniles suitable for restocking, the restocking program leaders decided to focus on just the wild supply of small lobsters.

Advice from consultation with lobster fishery biologists in the USA generated a number of considerations:

- Tagging of puerulus would be impossible, as the tagging procedure would kill them
- Minimum size for tagging should be around 1 gram, using a micro wire tag
- Tagging 1 gram lobsters with visual implant elastomer (VIE) tags has not been successful, as the tags disappeared before the lobsters reached fishing size
- Micro wire tagging has worked, but relies on all captured lobsters being scanned with a detector. This would have been difficult in Indonesia, and expensive, as detector units must be setup at every landing site so all lobsters pass through them
- VIE tagging was seen as more simple and inexpensive, although only useful for tagging lobsters of over 50 grams
- The recapture rates from previous USA studies were just a few losbters per 1000 tagged, so a useful tagging study must tag many thousands of lobsters to produce any meaningful results
- Because of the factors listed, the team was advised to choose just 1 or 2 sites for a tagging study
- Ideal study sites are those where the fishery is well defined and where the fishers ar managed so their catch can be monitored to retrieve tagged lobsters
- Because of the factors listed, a preliminary tagging study using different tag types on different size lobsters held in tanks was recommended.

Tagging of lobsters is necessary to distinguish those that have been translocated. It was assumed for the planned restocking program that group identification was sufficient and there was no need for identifying individual lobsters. It was deemed essential that the tag be retained through moulting, and would be suitable for tagging smaller lobsters.

Of the four tag types considered, the microwire tags were quickly ruled out due to their expense and difficulty of detection. Microwire tags have worked extremely well with lobsters (Sharp*, et al.*, 2000), and have an advantage over the other types of being suitable for very small lobsters down to 0.2 gram, however, they require specific detection equipment that involves scanning each individual lobster to determine if a tag is present. Such equipment with trained operators would need to be available at all landing sites for the lobster fishery in Indonesia, and on this basis the option was eliminated.

For the remaining three tag types, further consideration was made. The t-bar anchor tag is supplied by Hallprint Australia and can be printed with customised labels. This tag type is applied with a specialised applicator (Figure 1). T-bar tags are inserted into the abdominal muscle of lobsters in the suture between the head and tail. They are relatively cheap, easy to apply, highly visible and have a good retention rate. They are not suitable for very small lobsters – minimum size around 30-50 grams, but can be used for individual identification – useful for accurate growth estimates.

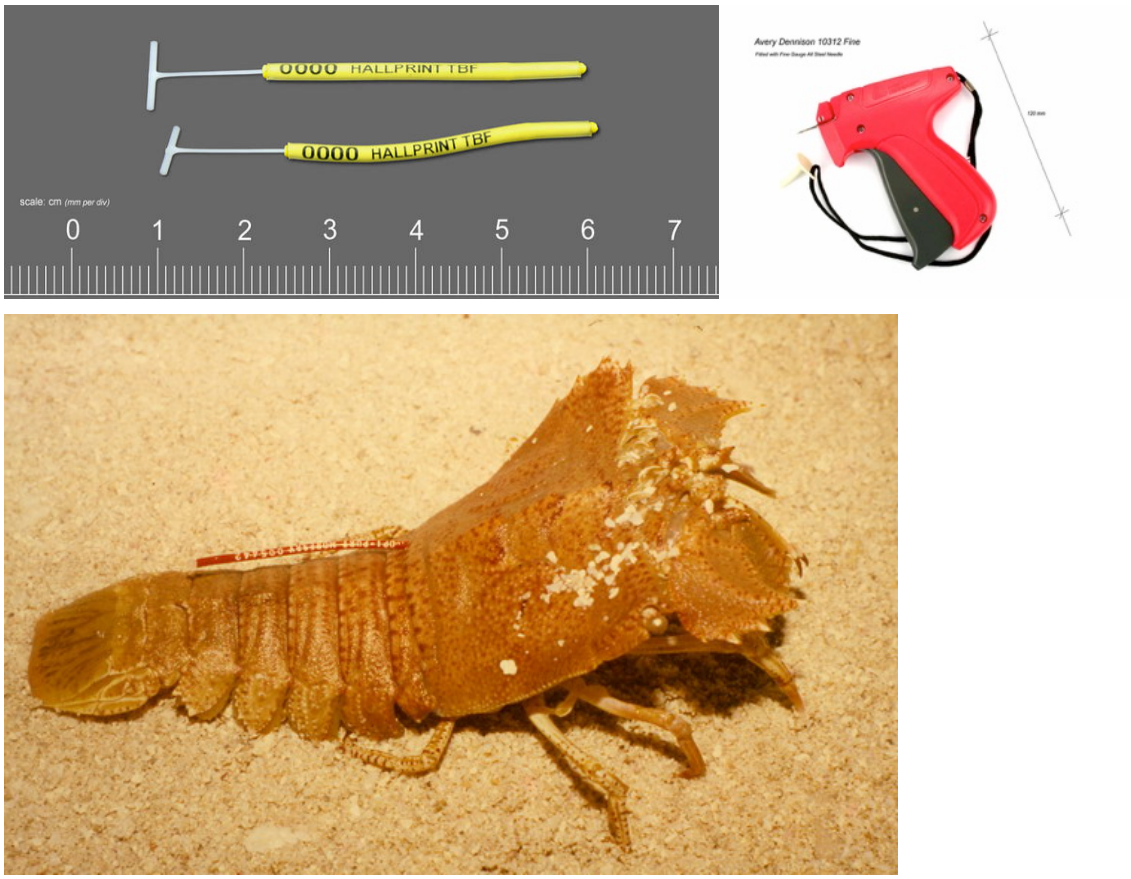

Figure 1. T-bar tag and applicator (top). Moreton bay bug with t-bar tag attached.

The poly streamer tag is also supplied by Hallprint Australia and can similarly be printed with a customised label. These tags however are attached manually with the needle supplied (Figure 2). They are of an equivalent cost to T-bar tags and easy, although slower to apply. They are highly visible, have good retention rate and are suitable for smaller lobsters – minimum size around 10-20 grams. They can also be used for individual identification for accurate growth estimates.

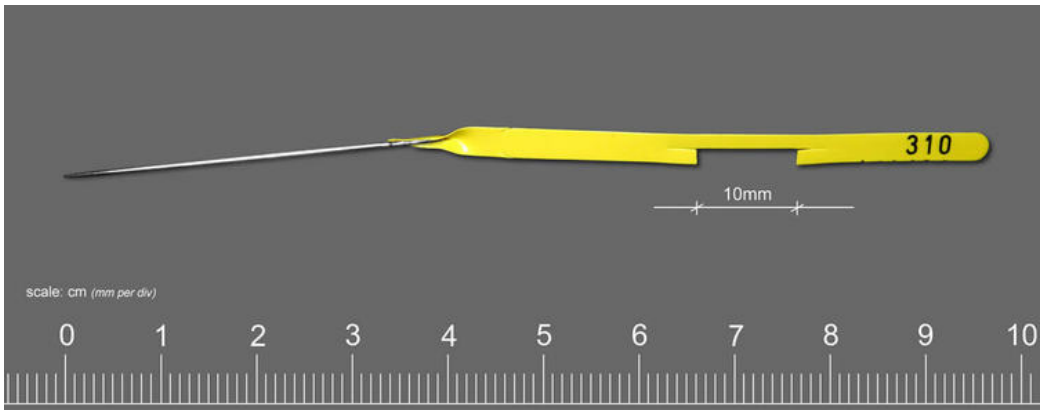

Figure 2. Poly streamer tag shown, and as applied to a lobster and a prawn.

The visual implant elastomer (VIE) tag is supplied by Northwest Marine Technology in the USA. They come in 6 colours but cannot be used for individual labeling. They are injected under transparent skin (Figure 3), in the case of lobsters on the under side of the tail (Figure 4). VIE tags are more expensive than the previous tag types, and less practical as the two-part elastomer must be mixed and used quickly before setting. They are moderately visible, but can become obscured by pigmentation and/or staining of tissue. They have a good retention rate, are suitable for very small lobsters – minimum size around 5-10 grams, but cannot be used for individual identification.

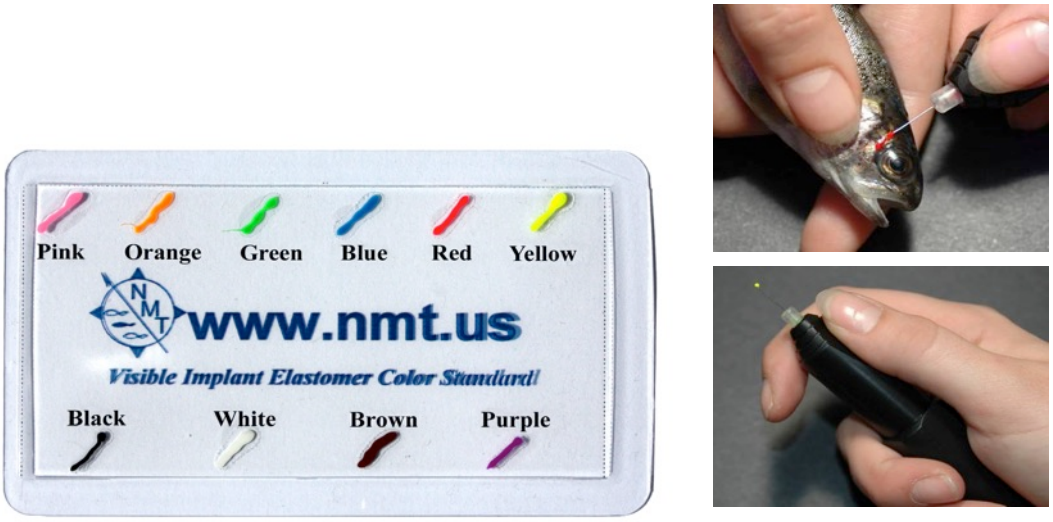

Figure 3. VIE tag colours (left) and application to transparent tissue in a fish (right).

Figure 4. For lobsters and crayfish (as pictured), the VIE tag is applied to the under side of the tail.

Although it was recommended that field studies be associated with tank studies to measure tag retention and tag induced mortality, the program leaders advised there would be insufficient time to conduct such studies. As a compromise, a short term tank based assessment was made as part of the tagging training.

7.2 Restocking considerations

Before embarking on the restocking program the team was advised to collect background statistics on existing lobster populations, to provide statistics upon which the impact of the restocking could be measured. Due to time pressure from the Ministry, it was apparent this data would not be collected.

The restocking group proposed several sites for restocking including; Pangandaran, Gunung Kidul, Pacitan, Prigi Trenggalek, Popoh Tulung Agung, Pulau Pari, Ujung Kulon, Kangean Madura, Simeulue, Mandeh Sumatera Barat and Tabanan Bali. Of these, only Pangandaran and Prigi had tank facilities that could be used as part of on-shore tagging. The on-going assessment of each site included qualitative information before restocking on habitat, facilities and infrastructure, local government perception and support, and various socio-economic considerations.

The restocking group decided that the proposed tagging size for lobsters would be 25 grams, with about 2.5 million individuals to be tagged at 9 sites. By the time of this report only Pangandaran and Prigi had been restocked, with several thousand tagged lobsters. The program also conducted habitat enhancement at the selected sites by deploying artificial lobster habitats.

8 Lobster Tagging Training

8.1 Tagging Training

The tagging training took place at the Marine Aquaculture Development Centre at Gerupuk Lombok on Wednesday August 19, 2015.

Danu Wijaya led the team of trainees with another 6 project staff participating. Tagging training was provided by Clive Jones with assistance of MADC staff, Samsul Bahrawi, Bayu Priyambodo and Muhammad Hidayat.

The MADC Director Pak Ujang supported the training by providing use of facilities for the tagging demonstration and monitoring of tagged lobsters. MADC arranged supply of 200 small lobsters (25-100g) to use for the training exercise.

Training comprised an introductory lecture to the trainees on tag types, methods of application and approaches to large scale field operations. This was followed by a practical demonstration whereby the instructor tagged lobsters of various sizes with the three tag types chosen, providing commentary on the handling and methodology involved. The trainees were then invited to each apply the procedures by tagging lobsters for themselves. Through an iterative process of demonstration, discussion and question and

answer, the trainees skill in successfully tagging lobsters increased quickly. Over a four hour period, all trainees appeared to have a high degree of competentcy. All lobsters tagged through the training were stocked to a nearby tank system for monitoring.

The monitoring of tagged lobsters was designed to assist in determining tag retention and tagging mortality. The tagged lobsters were held at MADC Gerupuk for 2 months to monitor their condition. This information was used to decide which tag to use for the field operations.

Through the tagging training exercise, 170 lobsters were successfully tagged. Of these, 70 lobster died over the following 4 weeks, with highest mortality from the polystreamer tag and least mortality with the VIE tag. Smaller lobsters (20-40g) had significantly higher mortality than the larger lobsters. In considering post tagging mortality, ease of tag application and tag visibility, the decision was made to use T-bar tags with 50g lobster as the basis for the restocking program.

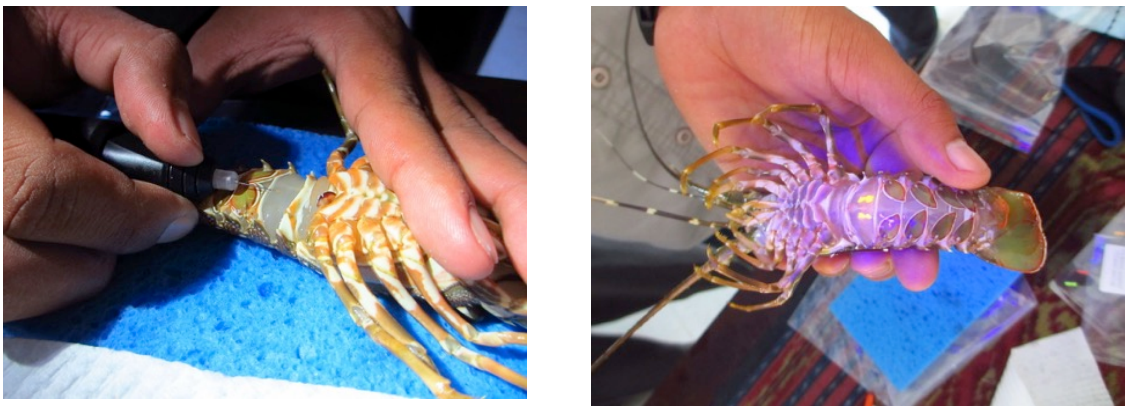

Figure 5. Images of tagging training activities.

9 Conclusions and recommendations

9.1 Conclusions

The provision of support by ACIAR to the Indonesian lobster restocking program was worthwhile as it provided specific advice and support of tagging, that was subsequently employed with success in the field. Although detailed statistics on the number of lobsters tagged and the return of tagged lobsters to date is not available, it is clear that more than 8,000 lobsters had been tagged by February 2016 with a small number of returns. Advice from Dr Fayakun in June 2016 was that the program had been successfully implemented, although his knowledge was limited as he had been transferred in March to another role.

The success of lobster restocking in regard to enhancement of lobster populations will take some years to measure, and is beyond the scope of the SRA. Nevertheless, a good working relationship and lines of communication between the restocking team and Dr Jones was established and will likely endure, such that further informal support will continue.

It can be concluded that tagging tropical lobsters with T-bar tags is a practical and cost-effective approach for application to a restocking program.

Provision of lobsters for translocation and restocking was from existing fisheries catch. To date there has been no Ministerial support for on-growing of lobster seed to produce lobsters for restocking as recommended. As the ACIAR lobster aquaculture project FIS/2014/059 will run until 2019, there is opportunity to provide support for on-growing if required.

9.2 Recommendations

The Indonesian Ministry of Marine Affairs and Fisheries should consider supporting on-growing of seed lobsters (pueruli), as they are plentiful in Indonesia, are likely to suffer very high natural mortality and growout technology is available through ACIAR FIS/2014/059. Use of such on-grown seed lobsters that would otherwise likely not have survived in nature could provide a net benefit to lobster populations. Translocating existing juvenile lobsters is unlikely to provide any net benefit and may have a detrimental impact

as the capture, handling and relocating of lobsters is likely to have a significant mortality effect.

More comprehensive evaluation of existing lobster population statistics should be made as a baseline from which the success of the enhancement program can be measured.

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