Invertebrate Gleaning: Forgotten Fisheries

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Abstract. Gleaning is important for the food security of many coastal communities, but data and information on these fisheries are extremely limited. Invertebrate gleaning is a popular fishing method in Bulukumba, Indonesia. The gleaners in Bulukumba recognised only one type, general gleaning. During general gleaning (2-4 hours), all species found will be collected. Women (95%) were more dominant than men (5%). The majority of gleaners utilize catch gleaning for food (62%) and a substantial majority for income (38%). A total of 15 species were collected and identified from gleaning catches, with 2,936 individual items. Gastropods were the dominated group (82.31%) followed by bivalves (7.36%), crustaceans (1.22%) and echinoderms (9.12%). Chicoreus brunneus was the dominant species in all gleaning sites except in Sama Bahari village, where the catch was dominated by Canarium urceus. Invertebrate gleaning plays an important role in providing food and income to coastal communities.

1. Introduction
Small-scale fisheries are defined broadly as the meaning of this term is often context dependent. Indeed this term can include all fisheries described as artisanal, subsistence, non-boat, non-motorized, and single occupant boat fisheries [1]. Invertebrate gleaning is one common but often overlooked category of small-scale fisheries. Invertebrate gleaning is a popular fishing method to collect invertebrates in many intertidal coastal areas [2,3,4], and in tropical regions it is usually conducted in reef flats, mangroves and seagrass meadows [5,6]. Seagrass meadows are a coastal ecosystem of ecological importance and often support a high level of biodiversity [7].

A number of studies have assessed invertebrate gleaning in coastal ecosystems [6,8,9,10] but descriptions of this activity in tropical waters are still minimal and more information is still needed. Invertebrate gleaning catch data are extremely limited due to this fishing method being frequently overlooked in fisheries data collection systems, in particular in Indonesia. Nonetheless, it is common knowledge that this fishing activity is popular in some coastal communities, both for food and as a source of additional income [6]. Indeed, it has been suggested that this activity is one of the most important methods of gathering invertebrates in coastal areas [9]. On other hand, it is suspected that this activity might damage seagrass ecosystems, with the impacts on biodiversity and invertebrate abundance in seagrass meadows [10].

This study aimed to observe and characterize invertebrate gleaning on intertidal seagrass areas, and to provide an assessment of why invertebrate gleaning is important to coastal community. We focussed on the importance of gleaning for coastal community livelihoods, food security, and also in terms of gender and the role of women. An improved socio-ecological understanding of gleaning should pave the way for improved management of these forgotten fisheries.
2. Methods
This study was conducted from February to March 2018 in the intertidal areas of four villages in Bulukumba District, South Sulawesi Province, Indonesia. Each site was selected due to its unique characteristics (Table 1 and Figure 1).

Table 1. Characteristics of four invertebrate gleaning sites in Bulukumba, South Sulawesi

| Location      | Status      | Anthropogenic activities                                                                 | Ecosystem/ substrate                      |
|---------------|-------------|------------------------------------------------------------------------------------------|-------------------------------------------|
| Kampung Beru  | Unregulated | Gleaning activities, close to harbour, boat mooring, close to coastal villages and shrimp pond | Seagrass meadows, sandy, muddy             |
| Lemo-lemo     | Unregulated | Gleaning activities, boat mooring, coastal tourism and close to coastal villages           | Seagrass meadows, sandy, rocky             |
| Panrang Luhu  | Unregulated | Gleaning activities, boat mooring, close to fish market, phinisi factory and coastal villages, tourism area and Bira harbour | Seagrass meadows, sandy, rocky             |
| Kasuso        | Unregulated | Gleaning activities, boat mooring, coastal tourism and close to coastal villages           | Seagrass meadows, sandy, rocky             |

Figure 1. Location of the four invertebrate gleaning sites in Bulukumba, South Sulawesi

Data collected consisted of gleaner profiles and gleaning catch. Data on gleaner profiles were collected using interviews and questionnaires. All gleaners found in the field were interviewed (census method), reflecting the gleaning population size in every site. A total of 62 gleaners were surveyed using a structured questionnaire (Table 2). Samples of gleaning catch were obtained by purchasing all the gleaning catch collected by the gleaners. The catch were counted and measured for estimation of species composition, catch volume, and animal abundance. Each animal was identified to the lowest possible taxonomic level, and reference specimens were collected in order to confirm identifications using [7], sealifebase.org, and gastropods.com. This study used a descriptive-
qualitative design to observe and analyse the gleaning invertebrate profile in the four selected gleaning areas in Bulukumba District, South Sulawesi, Indonesia. Gleaning catch data were analysed both statistically and descriptively.

Table 2. Structured questionnaire used to interview gleaners in the field

| Profile                                      |                      |
|----------------------------------------------|----------------------|
| What is your name?                           |                      |
| Gender                                       | (a) Man              |
|                                              | (b) Women             |
| Are you married?                             | (a) Yes              |
|                                              | (b) No                |
| Where is your home?                          | Open (divided into inside and outside the village) |
| What is your highest?                        | (a) Elementary school|
| Educational attainment?                      | (b) Junior high school|
|                                              | (c) Senior high school|
|                                              | (d) Higher education  |
|                                              | (e) None              |
| What do you do for living?                   |                      |
| What is your motivation for gleaning?        | (a) To eat           |
|                                              | (b) To sell          |
| How do you glean?                            | (a) Individually     |
|                                              | (b) In a group       |
| Perception                                   |                      |
| Are seagrasses similar to seaweeds?          | (a) Yes              |
|                                              | (b) No               |
|                                              | (c) No idea          |
| Can gleaning damage the seagrass?            | (a) Yes              |
|                                              | (b) No               |
|                                              | (c) No idea          |
| Will gleaning decrease the number of animals?| (a) Yes              |
|                                              | (b) No               |
|                                              | (c) No idea          |
| Is there a relationship between seagrass and gleaning catch? | (a) Yes, (positively correlated) |
|                                              | (b) No               |
|                                              | (c) Uncertain        |
|                                              | (d) No idea          |

3. Results and discussion

3.1. Invertebrate Gleaning Profile

*Mangesa* is the term used by the Bulukumba coastal community when they go looking for animals at low tide with simple tools. They often only use their bare hands, but additional tools can be used, for instance a plastic bag, basket, or net for gathering animals, or a short machete for hitting any fish that they find. Of the 62 gleaners interviewed, most were woman (95%) with far fewer men (5%). In terms of occupation, the most common response was housewife (34%). The majority of gleaners utilized their gleaning catch for food (62%); however a substantial minority also sold all or part of their catch for income (38%). The most frequent educational level reported by gleaners was elementary school (45%). The full gleaner profile data per site is shown in Table 3.

Around 76% of gleaners were aware that seagrasses and seaweed are different. More than half of gleaners (51%) considered that gleaning activities might damage the seagrass meadows by trampling, and a similar percentage (50%) considered that gleaning activities might decrease the abundance of the animals collected in nature. With respect to the relationship between seagrass and gleaning results, 48% gleaners considered that there is no relationship, 31% that they are related, 5% were uncertain and 16% had no idea (Table 4).
Table 3. Gleaner Composition in four gleaning sites

| Profile               | Kampung Beru | Lemo-Lemo | Panrang Luhu | Kasuso | Total |
|-----------------------|--------------|-----------|--------------|--------|-------|
|                       | N   | %   | N   | %   | N   | %   | N   | %   | N   | %   | N   | %   | N   | %   |
| Gender                |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Woman                 | 24  | 100 | 13  | 81  | 8   | 100 | 14  | 100 | 59  | 95  |       |     |     |     |
| Man                   | 0   | 0   | 3   | 19  | 0   | 0   | 0   | 0   | 3   | 5   |       |     |     |     |
| Marriage              |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Married               | 12  | 86  | 11  | 69  | 8   | 100 | 12  | 86  | 53  | 85  |       |     |     |     |
| Single                | 2   | 14  | 5   | 21  | 0   | 0   | 2   | 14  | 9   | 15  |       |     |     |     |
| Address               |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| In village            | 4   | 17  | 16  | 100 | 8   | 100 | 10  | 71  | 38  | 61  |       |     |     |     |
| Outside               | 20  | 83  | 0   | 0   | 0   | 0   | 4   | 29  | 24  | 39  |       |     |     |     |
| Education             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Elementary school     | 7   | 29  | 9   | 57  | 2   | 25  | 10  | 72  | 28  | 45  |       |     |     |     |
| Junior High School    | 6   | 25  | 1   | 6   | 5   | 63  | 1   | 7   | 13  | 21  |       |     |     |     |
| Senior High School    | 4   | 17  | 2   | 12  | 0   | 0   | 1   | 7   | 7   | 11  |       |     |     |     |
| Higher education None | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |       |     |     |     |
| Work                  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| None                  | 7   | 29  | 4   | 25  | 1   | 12  | 2   | 14  | 14  | 23  |       |     |     |     |
| Fisher                | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |       |     |     |     |
| Housewife             | 11  | 47  | 3   | 19  | 3   | 38  | 4   | 26  | 21  | 34  |       |     |     |     |
| Entrepreneur          | 2   | 8   | 3   | 19  | 4   | 50  | 9   | 64  | 18  | 30  |       |     |     |     |
| Farmer                | 8   | 33  | 4   | 25  | 0   | 0   | 1   | 8   | 13  | 21  |       |     |     |     |
| Labourer              | 1   | 4   | 4   | 25  | 0   | 0   | 0   | 0   | 5   | 8   |       |     |     |     |
| Jobless               | 2   | 8   | 2   | 12  | 1   | 12  | 0   | 0   | 4   | 6   |       |     |     |     |
| Utilization           |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Food                  | 23  | 96  | 9   | 56  | 7   | 86  | 10  | 71  | 49  | 79  |       |     |     |     |
| Income                | 1   | 4   | 7   | 44  | 1   | 14  | 4   | 29  | 13  | 21  |       |     |     |     |
| Pattern               |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Individual            | 13  | 54  | 13  | 81  | 6   | 75  | 13  | 93  | 45  | 72  |       |     |     |     |
| Group                 | 11  | 46  | 3   | 19  | 2   | 25  | 1   | 7   | 17  | 28  |       |     |     |     |
| Total                 | 24  | 100 | 16  | 100 | 8   | 100 | 14  | 100 | 62  | 100 |       |     |     |     |

Table 4. Gleaner perceptions on gleaning and seagrass ecosystems

| Gleaner perception                  | Kampung Beru | Lemo-Lemo | Panrang Luhu | Kasuso | Total |
|-------------------------------------|--------------|-----------|--------------|--------|-------|
|                                    | N   | %   | N   | %   | N   | %   | N   | %   | N   | %   | N   | %   | N   | %   |
| Are seagrasses similar to seaweeds? |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Yes                                 | 7   | 29  | 1   | 6   | 0   | 0   | 6   | 43  | 14  | 22  |       |     |     |     |
| No                                  | 17  | 71  | 15  | 94  | 7   | 55  | 8   | 57  | 47  | 76  |       |     |     |     |
| No Idea                             | 0   | 0   | 0   | 0   | 1   | 35  | 0   | 0   | 1   | 2   |       |     |     |     |
| Will gleaning damage the seagrass?  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Yes                                 | 11  | 46  | 10  | 62  | 3   | 37  | 8   | 57  | 32  | 51  |       |     |     |     |
| No                                  | 12  | 50  | 6   | 38  | 5   | 63  | 6   | 43  | 29  | 47  |       |     |     |     |
| No Idea                             | 1   | 4   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 2   |       |     |     |     |
| Will gleaning decrease the animals? |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Yes                                 | 6   | 25  | 10  | 62  | 2   | 25  | 13  | 93  | 31  | 50  |       |     |     |     |
| No                                  | 17  | 71  | 6   | 38  | 6   | 65  | 1   | 7   | 30  | 48  |       |     |     |     |
| No Idea                             | 1   | 4   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 2   |       |     |     |     |
| Is there a relationship between seagrass and gleaning results? |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Yes, in line                       | 8   | 34  | 8   | 50  | 1   | 13  | 2   | 14  | 19  | 31  |       |     |     |     |
| No                                 | 13  | 54  | 7   | 44  | 6   | 75  | 4   | 29  | 30  | 48  |       |     |     |     |
| Uncertain                          | 2   | 8   | 0   | 0   | 0   | 0   | 1   | 7   | 3   | 5   |       |     |     |     |
| No idea                            | 1   | 4   | 1   | 6   | 1   | 12  | 7   | 50  | 10  | 16  |       |     |     |     |
| Total                              | 24  | 39  | 16  | 26  | 8   | 13  | 14  | 22  | 62  | 100 |       |     |     |     |
In tropical Indonesian waters, invertebrate gleaning is one of the forgotten fisheries due to the extremely limited sources of data. Gleaning has been a traditional practise in many countries of the world [1,6,9,10,12], but comes in various forms, with two common categories: general and specific. Gleaning in Bulukumba fall in the general category, unlike in Banate Bay, Philippine [9] where both types of gleaning (general and specific) are practised.

Women’s use of the intertidal habitat domain is an important component in understanding the role of their fishing in the marine ecosystem, including invertebrate gleaning. In this study, gleaning was mainly practiced by women. In some other case studies, women have also been found to play important roles in providing protein and livelihoods through gleaning activities, for example in Al Wusta Governorate [13] and Central Philippines [1]. However the gender division of labour in gleaning fisheries is not absolute or universal. Instead, these divisions are diverse in ways that reflect both cultural and marine biophysical diversity. For example, in some Oceanic communities, women are forbidden from participating in some types of fishing [14] while among the Btisi’ of Malaysia most fishing is performed by opposite sex couples working together.

Gleaning plays an important role in providing food and income for coastal communities. In this study, the gleaning catch was mostly used for food, thus contributing to food security and nutrition more than to cash income. However, the proportion of the gleaners selling their catch was high enough (e.g. 44% at Lemo-Lemo) that the role of gleaning as a livelihood activity is far from negligible. Similar information has been reported from Tanzania [15] and Sumbawa Barat [16]. However a contrary situation is reported from the Albay Side of Lagonoy Bay [6], where most gleaners utilize their gleaning catch as a source of income.

3.2. Species Composition
A total of 15 different invertebrate macro faunal species were identified from all intertidal seagrass areas combined (Table 5). These species divided to different 4 groups like Bivalves, Crustaceans, Echinoderms and Gastropods. Gastropods were the common and dominant groups with 7 species (Figure 2). Canarium urceus and Anadara antique were the majority of species, both of them contributed around 80% from all species.

| Taxa          | Indonesian name          | Scientific name         | Kampung Beru | Lemo-lemo | Panrang Luhu | Kasuso |
|---------------|--------------------------|-------------------------|--------------|-----------|--------------|--------|
| Bivalves      | Boru-boru                | Anadara antique         | 491          | 1         | 0            | 1      |
|               | Biri-biri katinting      | Atriana vexillum        | 12           | 0         | 17           | 3      |
|               | Tude bombing             | Actodea striata         | 16           | 0         | 0            | 0      |
|               | Tude kepala bibir        | Gafarium tumidum        | 9            | 0         | 0            | 0      |
| Crustacea     | Kepting                  | Thalamita crenata       | 7            | 1         | 1            | 0      |
|               | Kepting cokelat          | Thalamita sima          | 0            | 1         | 0            | 0      |
| Echinoderms   | Tie-tie hijau            | Salmacis sphaeroides    | 154          | 1         | 0            | 0      |
| Gastropods    | Tie-tie merah            | Tripneustes gratilla    | 53           | 8         | 12           | 8      |
|               | Tiring-tirang            | Canarium urceus         | 2173         | 4         | 1            | 0      |
|               | Tittili                  | Chicoreus brunnus       | 30           | 0         | 18           | 3      |
|               | Dale                     | Conomurex luhuanus      | 0            | 17        | 136          | 105    |
|               | Batang-batang            | Conus marmoreus         | 20           | 9         | 48           | 9      |
|               | Binalu                   | Cypraea mauritiana      | 0            | 1         | 1            | 2      |
|               | Tedong-tedong            | Lambis-lambis           | 20           | 4         | 13           | 14     |
|               | Nangka duda              | Pleuroloca trapezium    | 4            | 0         | 0            | 0      |
| Total number  |                          |                         | 2,989        | 47        | 247          | 145    |
| Total number  |                          |                         | 12           | 10        | 9            | 8      |
Figure 2. Gleaning catch composition (%); the most common higher level taxon was Gastropods, comprising over 80% of invertebrates harvested

The substrate in all gleaning sites consisted of sand, mud, coral fragments and seagrass beds. Gastropods dominated the invertebrate gleaning catches at all sites, outnumbering echinoderms, crustaceans and bivalves. Bivalves, crustaceans and gastropods are widely considered to be groups of animals associated with seagrass meadows [10,17]. Habitat structure and composition are the mainly drivers influencing the dominance of Canarium urceus [18], the most common species in gleaning catches at the Kampung Beru site (72.70% of the catch) where the mainly sandy substrate is covered by seagrass. Meanwhile, Chicoreus brunneus, the dominant species in Lemo-lemo (36.17%), Panrang Luhu (55.06%) and Kasuso (72.41%), is a species reported to live in seagrass meadows with sandy and muddy substrate [19,20].

4. Conclusion
Invertebrate gleaning can be considered a forgotten fishery, however from an economic standpoint; it directly and indirectly affects and contributes to overall fishing activities. Invertebrate gleaning also provides a source of food for coastal communities. There is only one type of invertebrate gleaning in Bulukumba district, general gleaning. The majority of gleaners thought that there was no similarity between seagrasses and seaweed, and around half of gleaners considered that gleaning activities might damage the seagrass meadows, while a similar proportion thought that gleaning activities might decrease the abundance of target animals. There were 15 species collected, and catch composition at all four gleaning sites was dominated by gastropods. In terms of catch diversity at each site the highest number of species was 12 and the lowest 8 species. In addition to direct impacts, invertebrate gleaning may in turn have an impact on economically important species due to “ecosystem over fishing”. In-depth studies on these topics should be undertaken. The need for biodiversity conservation and management studies and the issues associated with health and safety hazards are likewise recommended as factors in planning and management to sustain the resource on a long-term basis.

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