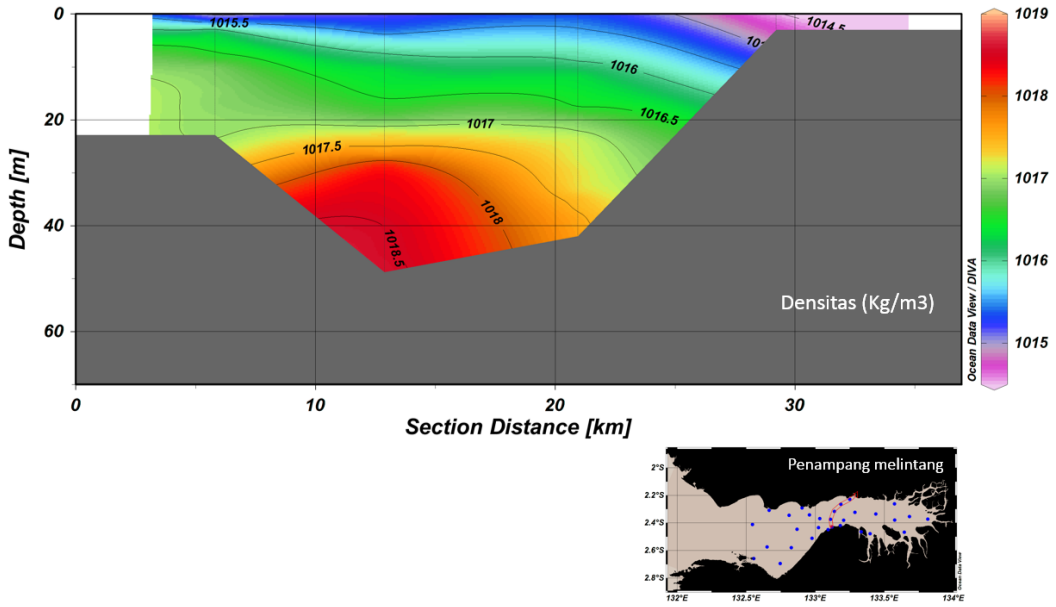


Figure II-140 Cross-section of Density (kg/m³) from the North Side to the South Side in the Bay Central Part During the Southeast Monsoon

2.2 BIOLOGY

2.2.1 Terrestrial Biology

As described in the ANDAL Terms of Reference document agreed by Minister of the Environment, the Tangguh LNG has performed several biological diversity surveys to illustrate the biological environmental conditions in the Tangguh LNG areas. The surveys are:

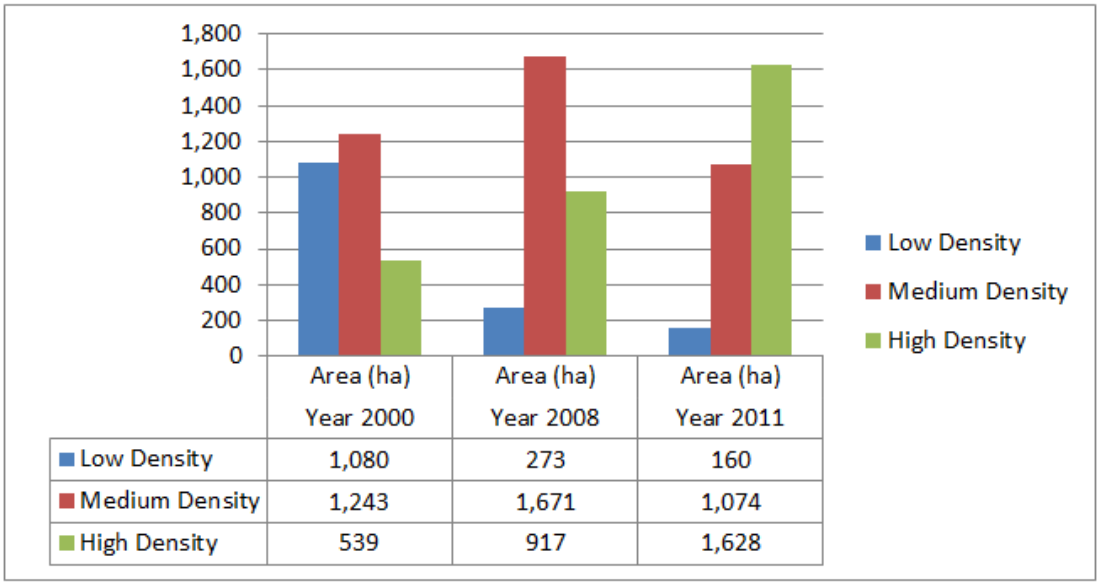
1. Environmental baseline study for ANDAL 2002;
2. Flora and Fauna Survey in the Tangguh LNG Project Site in 2007; and
3. Monitoring of Flora and Fauna at Tangguh LNG in 2011.

Land Cover

In the flora and fauna monitoring report 2011, it is described that in general the major forest ecosystem type at the proposed location of the Tangguh LNG Expansion Project consists of (1) mangrove forest, (2) swamp forest, and (3) lowland forest. Forest areas cleared for the Tangguh LNG activities are totally 3,266 ha, but only 365 ha (11.18%) of the area is cleared for the expansion of Tangguh LNG site and 39 ha of the area is fenced as a buffer zone. Of the cleared area, approximately 100 ha have been re-vegetated. Further, for the development of the LNG Plant facilities and its supporting facilities required as part of the Tangguh LNG Expansion Project, land clearing of maximum 500 ha is needed.

Analysis results of satellite images over a period of ten years (Landsat Images year 2000, 2008 and 2011) indicate the vegetation density level in the Buffer Zone area. The vegetation density condition in the buffer zone area from 2000 to 2011 is as presented in **Figure II-141**.

Based on **Figure II-141,** it can be observed that areas with sparse vegetation density levels are decreasing i.e. from 1,080 ha (38%) in 2000, to 273 ha (9%) in 2008 and to 160 ha (6%) in 2011. However, on the contrary the medium vegetation density level slightly fluctuated i.e. from 1,243 ha (43%) in 2000 to 1,671 ha (58%) in 2008 and decreased to 1,074 ha (37%) in 2011. These changes may be due to the changes of the medium vegetation density in 2008 to dense vegetation in 2011. Therefore, consistently the dense vegetation density increased from 539 ha (19%) in 2000, to 917 ha or (32%) in 2008 and furthermore increased to 1,628 ha (57%) in 2011.



	Area (ha) Year 2000	Area (ha) Year 2008	Area (ha) Year 2011
Low Density	1,080	273	160
Medium Density	1,243	1,671	1,074
High Density	539	917	1,628

Source: Analysis results of Landsat Images, 2011 by the IPB Team for the Report of the Tangguh LNG Flora and Fauna Survey

Figure II-141 Vegetation Density in the Buffer Zone from 2000 to 2011

From the analysis results, there is an increase in the extent of dense vegetation. This is due to the fencing performed by the Tangguh LNG resulting in a limited access for outsiders to undertake any activities in this area. Apart from the limited human activities due to the fencing, this also results in control on logging activities, thus providing space and time for the existing vegetation to experience natural recovery processes (natural succession). The Tangguh LNG also performed re-vegetation in this area by prioritizing the planting of local species.

Landsat 5 and 7 ETM images **Figure II-142** indicates that the land clearing activities only occur at the Tangguh LNG site (LNG Train 1 and 2 as well as its existing supporting facilities), and there will no land clearing activities in the buffer zone of

the Tangguh LNG Project (2,852 ha). **Figure II-143** indicates the vegetation density level based on the NDVI analysis in the buffer zone of the Tangguh LNG based on Landsat 5 and Landsat 7 ETM Images, year 2000, 2008 and 2011.

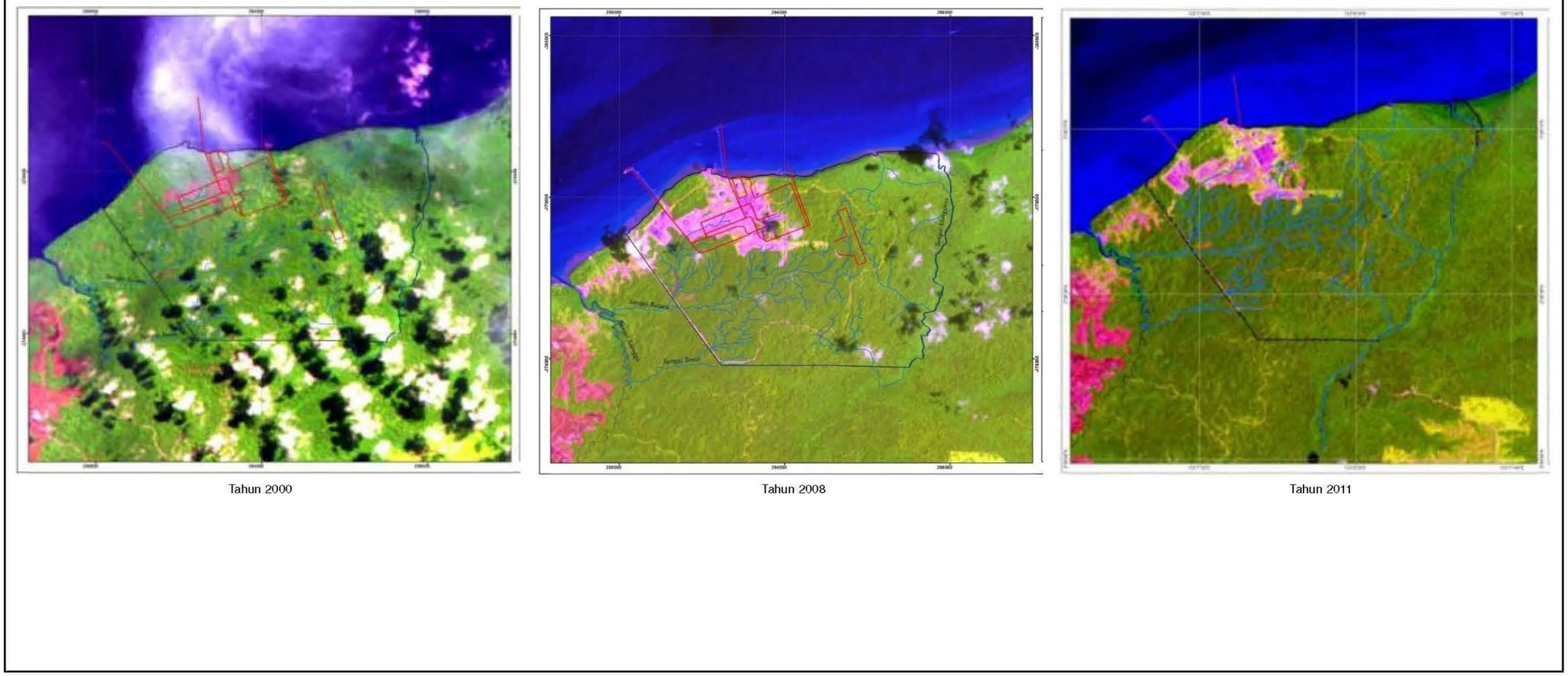


Figure II-142 Land Closure Conditions at the Tangguh LNG Buffer Zone, Based on Landsat 5 and Landsat 7 ETM Images, Year 2000, 2008 and 2011

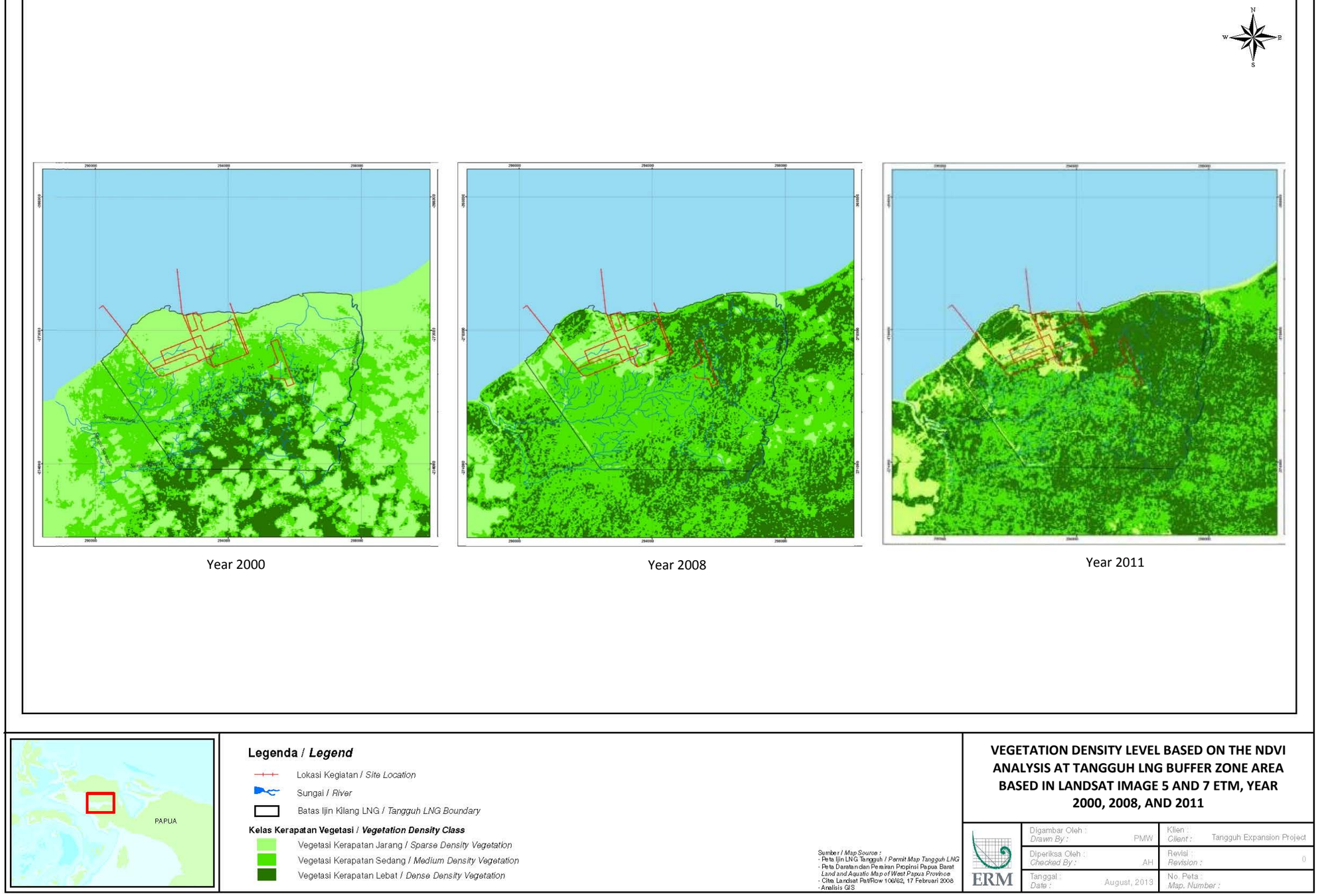


Figure II-143 Vegetation Density Level Based on the NDVI Analysis at the Tangguh LNG Buffer Zone Based on the Landsat 5 and Landsat 7 ETM Images, Year 2000, 2008 and 2011

2.2.1.1 Terrestrial Flora

Structure and Composition of Species – Forest Stand

Density of Plant Species

Lowland Forest

Based on the survey in 2011, three transects were performed to identify the lowland forest vegetation composition in the Tangguh LNG area. At transect-1, tree habitus plant species with the highest density at the tree level is Kibo (*Xylopia caudata*) with a density of 19 individuals/ha; the pole level is Jabon (*Anthocephalus chinensis*) with a density of 60 individuals/ha; the sapling level is Mahang (*Macaranga involucrata*) with a density of 420 individuals/ha; and the seedling level is Watartesa, Senapa, Senepa, Sapartesa (*Rhodamnia latifolia*) with a density of 750 individuals/ha.

The densities of five tree-habitus plant species with the highest density in lowland forest of Transect-1 in the Tangguh LNG area are presented in **Table II-50.**

Table II-50 The Densities of the Five Tree-Habitus Plant Species with the Highest Density at Transect-1 in Lowland Forest at the Tangguh LNG Area

Level of Growth	Local Name	Scientific Name	Density (individuals/ha)
Tree	Kibo	*Xylopia caudata Hook.f. & Thoms.*	19
	Jabon	*Anthocephalus chinensis (Lamk.) Rich. Ex Walp.*	13
	Tangguh, dura, sea, tago, tagoh	*Goniothalamus aruensis Scheff.*	5
	Merbau	*Intsia bijuga A. Gray.*	5
	Siwa, tago	*Alphitonia incana (Roxb.) Teijsm.& Binn. ex Kurz.*	5
Pole	Jabon	*Anthocephalus chinensis (Lamk.) Rich. Ex Walp.*	60
	Koma	*Ficus variegata Bl.*	35
	Tororo, koma	*Ficus virens W. Ait.*	35
	Sinatibi	*Macaranga aleuritoides F. Muell.*	30
	Mahang	*Macaranga involucrata (Roxb.) Baillon*	25
Sapling	Mahang	*Macaranga involucrata (Roxb.) Baillon*	420
	Sinatibi	*Macaranga aleuritoides F. Muell.*	260
	Tororo, koma	*Ficus virens W. Ait.*	200
	Kisawe, kisawai, sawi	*Pleomele angustifolia (Roxb.) N.E. Br.*	180
	Mahang daun besar	*Macaranga gigantea (Reichb.f. & Zoll.) Muell. Arg.*	180
Seedling	Watartesa, senapa, senepa, sapartesa	*Rhodamnia latifolia (Benth.) Miq.*	750
	Sp1-T2P9	*Brookea tomentosa Benth.*	750
	Idona	*Ficus obscura Bl.*	625
	Witai, weto	*Mangifera foetida Lour.*	500
	Kiwikebe	*Vitex trifolia L.*	500

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

At Transect-2 in lowland forest, tree habitus plant species with the highest density at the tree level is Damar, Arowe, Kibi, Parada, Marada (*Vatica Rasak*) with a density of 29 individuals/ha; at the pole level is Damar (*Macaranga labilardieri*) with a density of 40 individuals/ha; at the sapling level is Mahang (*Macaranga involucrata*) with a density of 560 individuals/ha; and at the seedling level is Damar, Arowe, Kibi, Marada, Marada (*Vatica Rassak*) with a density of 1,750 individuals/ha. The densities of the five tree habitus plant species with the highest density at Transect-2 lowland forest in the Tangguh LNG area are presented in **Table II-51**.

Table II-51 The Densities of the Five Tree Habitus Plant Species with the Highest Density at Transect-2 in Lowland Forest at the Tangguh LNG Area

Level of Growth	Local Name	Scientific Name	Density (individuals/ha)
Tree	Damar, arowe, kibi, parada, marada	*Vatica rassak (Korth.) Bl.*	29
	Damar	*Agathis labilardieri Warb.*	29
	Kibo	*Xylopia caudata Hook.f. & Thoms.*	14
	Kayu minyak	*Goniothalamus cauliflorus K. Sch.*	10
	Wakore	*Santiria griffithii Engl.*	9
Pole	Damar	*Agathis labilardieri Warb.*	40
	Mahang	*Macaranga involucrata (Roxb.) Baillon*	25
	Damar, arowe, kibi, parada, marada	*Vatica rassak (Korth.) Bl.*	20
	Kiwibi	*Memecylon cf. oleaefolium Baker*	20
	Jabon	*Anthocephalus chinensis (Lamk.) Rich. Ex Walp.*	15
Sapling	Mahang	*Macaranga involucrata (Roxb.) Baillon*	560
	Sp-1 T1P7	*Champereia manillana (Bl.) Merrill*	420
	Sinatibi	*Macaranga aleuritoides F. Muell.*	260
	Tororo, koma	*Ficus virens W. Ait.*	240
	Kisawe, kisawai, sawi	*Pleomele angustifolia (Roxb.) N.E. Br.*	200
Seedling	Damar, arowe, kibi, parada, marada	*Vatica rassak (Korth.) Bl.*	1,750
	Tree-1 T3P5	*Aceratium ledermannii Schltr.*	1,500
	Pinang	*Areca catechu L.*	1,125
	Wena	*Xylopia malayana Hook.f. & Thoms.*	1,125
	Mateya, matea, kefe	*Evodia elleryana F. & M.*	750

Source : Flora and Fauna Survey Result Report at Tangguh LNG Project Site Year 2011

At Transect-3 in lowland forest, tree habitus plant species with the highest density at the tree level is Merbau (*Intsia bijuga*) with a density of 15 individuals/ha; at the pole level is Soma-soma, Kofa (*Baringtonia racemosa*) with a density of 27 individuals/ha; at the Sapling level is Soma-soma, Kofa (*Baringtonia racemosa*) with a density of 293 individuals/ha; and at the seedling level is the delicate Palm leaf (*Gulubia costata*) with a density of 2,333 individuals/ha. The densities of the five tree habitus plant species with the highest density at Transect-3 in lowland forest are presented in **Table II-52.**.

Table II-50 The Densities of the Five Tree Habitus Plant Species with the Highest Density at Transect-3 in Lowland Forest at Tangguh LNG Areas

Level of Growth	Local Name	Scientific Name	Density (individuals/ha)
Tree	Merbau	*Intsia bijuga A. Gray.*	15
	Wata, matoa	*Pometia pinnata J.R. & G. Forst.*	13
	Jabon	*Anthocephalus chinensis (Lamk.) Rich. Ex Walp.*	13
	Kiwibi, kiwi	*Hymenaea courbaril Linn.*	10
	Adaura	*Artocarpus teysmannii Miq.*	7
Pole	Soma-soma, kofa	*Barringtonia racemosa Hort. ex Miq.*	27
	Seri	*Glochidion lutescens Bl.*	13
	Watartesa, senapa, senepa, sapartesa	*Rhodamnia latifolia (Benth.) Miq.*	13
	Senau	*Palaquium sericeum H.J. Lam*	13
	Tororo, koma	*Ficus virens W. Ait.*	13
Sapling	Soma-soma, kofa	*Barringtonia racemosa Hort. ex Miq.*	293
	Sukun hutan	*Artocarpus altilis (Parkinson) Fosberg.*	267
	Watartesa, senapa, senepa, sapartesa	*Rhodamnia latifolia (Benth.) Miq.*	240
	Sp-15 T3	*Ficus tinctoria Forst. f. subsp. tinctoria*	240
	Senau	*Palaquium sericeum H.J. Lam*	213
Seedling	Palem daun halus	*Gulubia costata (Becc.) Becc.*	2,333
	Sp-1 T1P7	*Champereia manillana (Bl.) Merrill*	1,167
	Kisawe, kisawai, sawi	*Pleomele angustifolia (Roxb.) N.E. Br.*	1,000
	Watartesa, senapa, senepa, sapartesa	*Rhodamnia latifolia (Benth.) Miq.*	1,000
	Damar, arowe, kibi, parada, marada	*Vatica rassak (Korth.) Bl.*	833

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project location year 2011

Swamp Forest

Swamp forest in the Tangguh LNG area that have tree habitus plant species with a highest density at the tree and seedling level is the Watura (*Bruguirea parviflora*) with a density of respectively 42 individuals/ha and 2,000 individuals/ha; while at the pole and sapling levels is the Kakabora/Kakabaura (*Dolichandrone spathacea*) with a density of respectively 67 individuals/ha and 1,467 individuals/ha. Plant species with the highest density at every growth level are presented in **Table II-53**.

Table II-51 Plant Species with the Highest Density at Every Growth Level in Swamp Forest at the Tangguh LNG Area

Level of Growth	Local Name	Scientific Name	Density (individuals/ha)
Tree	Watura	*Bruguirea parviflora (Roxb.) Wight. & Arn.*	42
	Kakabora, kakabaura	*Dolichandrone spathacea (L.f.) K. Sch.*	38
	Kimura, kiriri, kiropa	*Pongamia pinnata (L.) Pierre*	12
	Wisi, kibisi	*Inocarpus fagiferus (Parkinson) Forsb.*	2
	Kitis, kitisi	*Hibiscus tiliaceus L.*	2
Pole	Kakabora, kakabaura	*Dolichandrone spathacea (L.f.) K. Sch.*	67
	Watura	*Bruguirea parviflora (Roxb.) Wight. & Arn.*	47
	Wisi, kibisi	*Inocarpus fagiferus (Parkinson) Forsb.*	20
	Kimura, kiriri, kiropa	*Pongamia pinnata (L.) Pierre*	20
	Soma-soma, kofa	*Barringtonia racemosa Hort. ex Miq.*	13
Sapling	Kakabora, kakabaura	*Dolichandrone spathacea (L.f.) K. Sch.*	1,467
	Kitis, kitisi	*Hibiscus tiliaceus L.*	693
	Wisi, kibisi	*Inocarpus fagiferus (Parkinson) Forsb.*	427
	Kimura, kiriri, kiropa	*Pongamia pinnata (L.) Pierre*	320
	Soma-soma, kofa	*Barringtonia racemosa Hort. ex Miq.*	213
Seedling	Watura	*Bruguirea parviflora (Roxb.) Wight. & Arn.*	2,000
	Kitis, kitisi	*Hibiscus tiliaceus L.*	667
	Kakabora, kakabaura	*Dolichandrone spathacea (L.f.) K. Sch.*	333
	Benabo	*Ficus sp.*	167

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Mangrove Forest

Tree habitus plant species with the highest density in mangrove forest are as follows: at the tree and pole level is Sapo (*Sonneratia alba*) with a density of respectively 149 individuals/ha and 60 individuals/ha; at the Sapling and seedling level is Weda laut (*Avicennia marina*) with a density of respectively 780 individuals/ha and 1,875 individuals/ha. Plant species with the highest density at every growth level in the mangrove forest in the Tangguh LNG areas presented in **Table II-54**.

Table II-52 Plant Species with the Highest Density at Every Growth Level in Mangrove Forest at the Tangguh LNG Area

Level of Growth	Local Name	Scientific Name	Density (individuals/ha)
Tree	Sapo	*Sonneratia alba J. Smith.*	149
	Weda laut	*Avicennia marina (Forst.f.) Bakh.*	4
Pole	Sapo	*Sonneratia alba J. Smith.*	60
	Weda laut	*Avicennia marina (Forst.f.) Bakh.*	65
Sapling	Weda laut	*Avicennia marina (Forst.f.) Bakh.*	780
	Watora, tonate, wabi-wabi	*Rhizophora apiculata Bl.*	220

Level of Growth	Local Name	Scientific Name	Density (individuals/ha)
	Sapo	*Sonneratia alba J. Smith.*	100
Seedling	Weda laut	*Avicennia marina (Forst.f.) Bakh.*	1,875
	Sapo	*Sonneratia alba J. Smith.*	875
	Watora, tonate, wabi-wabi	*Rhizophora apiculata Bl.*	375

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Cover crop

Cover crop species with the highest density in lowland forest at Transect-1 is Grintingan (*Cynodon dactylon*); Transect-2 is Tesa/Wantaro/Taa/Siropa (*Taenitis blechnoides*); and Transect-3 is Owe-owe (*Selaginella plana*). The list of five cover crop species with the highest Important Value Index (IVI) at lowland forest ecosystem is presented in **Table II-55**..

Table II-53 Five Cover crop Species with the Highest IVI at Lowland Forest Ecosystem Type

Transect	Local Name	Scientific Name	Density (individuals/ha)
Transect-1	Grintingan	*Cynodon dactylon Pers.*	6,250
	Tesa, wantaro, taa, siropa	*Taenitis blechnoides (Willd.) Swartz.*	2,250
	Nede-nede, nida-nida	*Melastoma malabathricum Linn.*	1,875
	Palas duri	*Licuala brevicalyx Becc.*	1,125
	Pandan	*Pandanus sp.*	1,000
Transect-2	Tesa, wantaro, taa, siropa	*Taenitis blechnoides (Willd.) Swartz.*	3,000
	Nede-nede, nida-nida	*Melastoma malabathricum Linn.*	1,625
	Palem daun halus	*Gulubia costata (Becc.) Becc.*	1,125
	Batisa, nesanububu	*Pityrogramma calomelanos (L.) Link.*	1,000
	Watora	*Nephrolepis falcata (Cav.) C. Chr.*	875
Transect-3	Owe-owe	*Selaginella plana (Desv.) Hieron*	2,333
	Musuri	*Alpinia sp.*	833
	Musuri huruma	*Zingiber sp.*	333
	Nede-nede, nida-nida	*Melastoma malabathricum Linn.*	167
	Sopage	*Donax cannaeformis (G. Forst.) K. Schum.*	167

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

In swamp forest, cover crop species that have the highest density is Pandan (*Pandanus sp.)* with a density of 3,330 individuals/ha. While in mangrove forest cover crop species are not found. The list of the cover crop species with the highest IVI at the swamp forest ecosystem is presented in **Table II-56.**

Table II-54 Five Cover crop Species with the Highest IVI at Swamp Forest Ecosystem Type

Local Name	Scientific Name	Density (individuals/ha)
Pandan pohon, paku pohon	*Pandanus sp.*	3,330
Yatesa, catesa, piyai	*Acrostichum aureum L.*	2,500
Kafenisa	*Acanthus ilicifolius L.*	1,670
Kafirsa, kafirsa huruma	*Paspalum conjugatum Berg.*	670
Firiwo	*Crinum asiaticum L.*	500

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Epiphytes and Liana

At the epiphytes and liana habitus, plant species that have the highest density in lowland forest at Transect-1 is *Bunga ternate* (*Clitoria ternatae*) with a density of 68 individuals/ha; while at Transect-2 and Transect-3 is *Kagetisa daun besar/sedang* (*Rhaphidophora sylvestris (Bl) Engl.)* with a density of respectively 74 individuals/ha and 142 individuals/ha. **Table II-57** presents the five epiphyites and liana habitus species with highest IVI at the lowland forest ecosystem type.

Table II-55 Five Epiphytes and Liana Habitus Species with the Highest IVI at the Lowland Forest Ecosystem Type

Transect	Local Name	Scientific Name	Density (individual/ha)
Transect-1	Bunga ternate	*Clitoria ternatae L.*	68
	Pipi kisiri, deda	*Mikania cordata (Burm.f.) B.L. Robinson*	55
	Rotan daun halus	*Calamus sp. 1*	30
	Yesirara	*Flagellaria indica L.*	30
	Rotan T1P1-1	*Calamus aruensis Becc.*	29
Transect-2	Kagetisa daun besar/sedang	*Rhaphidophora sylvestris (Bl.) Engl.*	74
	Muki	*Freycinetia graminea Bl.*	44
	Rotan T1P1-1	*Calamus aruensis Becc.*	34
	Tantega	*Uncaria glabrata (Bl.) DC.*	33
	Yesirara	*Flagellaria indica L.*	29
Transect-3	Kagetisa daun besar/sedang	*Rhaphidophora sylvestris (Bl.) Engl.*	142
	Kagetisa daun kecil	*Pothos falcifolius Engl. & K. Krause*	75
	Sapo-sapo, sapara	*Ficus pumila L.*	60
	Rotan T1P1-1	*Calamus aruensis Becc.*	37
	Muki	*Freycinetia graminea Bl.*	18

Source: Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

In swamp forest, the epiphytes and liana habitus species that have the highest density is the Yesilara (*Flagellaria indica*) with a density of 105 individuals/ha. Five epiphytes and liana habitus species with the highest IVI in swamp forest ecosystems are presented in **Table II-58.**

Table II-56 Five Epiphytes and Liana Habitus Species with the Highest Important Value Index at the Swamp Forest Ecosystem Type

Local Name	Scientific Name	Density (individual/ha)
Yesirara	*Flagellaria indica L.*	105
Kagetisa daun kecil	*Pothos falcifolius Engl. & K. Krause*	103
Kagetisa daun besar/sedang	*Rhaphidophora sylvestris (Bl.) Engl.*	37
Fiso	*Derris trifoliata Lour.*	28
Wadatene	*Asplenium nidus L.*	22

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

While in the mangrove forest, the epiphytes and liana species that have the highest density is the Wadatene (*Lecanopteris carnosa*) with a density of 15 individuals/ha. Three species of epiphytes and liana habitus with the highest IVI at the mangrove forest ecosystem type are presented in **Table II-59.**

Table II-57 Three Epiphytes and Liana Habitus Plant Species with Highest IVI at the Mangrove Forest Ecosystem Type

Local Name	Scientific Name	Density (individual/ha)
Wadatene	*Lecanopteris carnosa (Reinw.) Bl.*	15
Wadatene	*Asplenium nidus L.*	6
Wetara	*Drynaria sparsisora (Desv.) Moore*	4

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Domination of Plant Species

Lowland Forest

Dominant plant species at Transect-1 in lowland forest at tree level is dominated by Kibo (*Xylopia caudata*) with an IVI of 78.15 %; the pole level is dominated by Jabon (*Anthocephalus chinensis*) with an IVI of 49.77 %; the sapling level is dominated by Mahang (*Macaranga involucrata*) with an IVI of 22.86 %; and the seedling level is dominated by Watartesa, Senapa, Senepa, Sapartesa (*Rhodamnia latifolia*) with an IVI of 19.09 %. Five tree habitus plant species with highest IVI at Transect-1 in lowland forest are presented in **Table II-60**.

Table II-58 Five Tree Habitus Plant Species with Highest IVI at Transect-1 in Lowland Forest

Level of Growth	Local Name	Scientific Name	IVI (%)
Tree	Kibo	*Xylopia caudata Hook.f. & Thoms.*	78.15
	Jabon	*Anthocephalus chinensis (Lamk.) Rich. Ex Walp.*	35.97
	Tangguh, dura, sea, tago, tagoh	*Goniothalamus aruensis Scheff.*	19.98
	Merbau	*Intsia bijuga A. Gray.*	19.84
	Siwa, tago	*Alphitonia incana (Roxb.) Teijsm.& Binn. ex Kurz.*	18.32

Level of Growth	Local Name	Scientific Name	IVI (%)
Pole	Jabon	*Anthocephalus chinensis (Lamk.) Rich. Ex Walp.*	49.77
	Koma	*Ficus variegata Bl.*	30.15
	Tororo, koma	*Ficus virens W. Ait.*	28.77
	Mahang	*Macaranga involucrata (Roxb.) Baillon*	23.58
	Siwa, tago	*Alphitonia incana (Roxb.) Teijsm.& Binn. ex Kurz.*	21.29
Sapling	Mahang	*Macaranga involucrata (Roxb.) Baillon*	22.86
	Sinatibi	*Macaranga aleuritoides F. Muell.*	12.98
	Kisawe, kisawai, sawi	*Pleomele angustifolia (Roxb.) N.E. Br.*	10.51
	Mahang daun besar	*Macaranga gigantea (Reichb.f. & Zoll.) Muell. Arg.*	10.51
	Watartesa, senapa, senepa, sapartesa	*Rhodamnia latifolia (Benth.) Miq.*	10.51
Seedling	Watartesa, senapa, senepa, sapartesa	*Rhodamnia latifolia (Benth.) Miq.*	19.09
	Sp1-T2P9	*Brookea tomentosa Benth.*	16.82
	Witai, weto	*Mangifera foetida Lour.*	13.48
	Idona	*Ficus obscura Bl.*	12.88
	Kiwikebe	*Vitex trifolia L.*	11.21

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Dominant plant species at Transect-2 in lowland forest at tree level is dominated by Damar, Arowe, Kibi, Parada, Marada (*Vatica rassak*) with an IVI of 39.40%; the pole level is dominated by Damar (*Agathis labilardieri*) with an IVI of 32.95%; the sapling level is dominated by Mahang (*Macaranga involcrata*) with an IVI of 18.97; and at the seedling level is dominated by Damar, Arowe, Kibi, Parada and Marada (*Vatica* rassak) with an IVI of 18.92%. Five tree habitus plant species with highest IVI at Transect-2 in lowland forest are presented in **Table II-61**.

Table II-59 Five Tree Habitus Plant Species with Highest IVI at Transect-2 in Lowland Forest

Level of Growth	Local Name	Scientific Name	IVI (%)
Tree	Damar, arowe, kibi, parada, marada	*Vatica rassak (Korth.) Bl.*	39.40
	Damar	*Agathis labilardieri Warb.*	35.45
	Kibo	*Xylopia caudata Hook.f. & Thoms.*	29.01
	Merbau	*Intsia bijuga A. Gray.*	21.92
	Kayu minyak	*Goniothalamus cauliflorus K. Sch.*	16.03
Pole	Damar	*Agathis labilardieri Warb.*	32.95
	Damar, arowe, kibi, parada, marada	*Vatica rassak (Korth.) Bl.*	22.14
	Mahang	*Macaranga involucrata (Roxb.) Baillon*	20.34
	Jabon	*Anthocephalus chinensis (Lamk.) Rich. Ex Walp.*	14.98
	Kiwibi	*Memecylon cf. oleaefolium Baker*	14.15
Sapling	Mahang	*Macaranga involucrata (Roxb.) Baillon*	18.97
	Sp-1 T1P7	*Champereia manillana (Bl.) Merrill*	16.81
	Kisawe, kisawai, sawi	*Pleomele angustifolia (Roxb.) N.E. Br.*	11.78
	Tororo, koma	*Ficus virens W. Ait.*	10.63
	Sinatibi	*Macaranga aleuritoides F. Muell.*	10.06

Level of Growth	Local Name	Scientific Name	IVI (%)
Seedling	Damar, arowe, kibi, parada, marada	*Vatica rassak (Korth.) Bl.*	18.92
	Pohon-1 T3P5	*Aceratium ledermannii Schltr.*	18.81
	Mateya, matea, kefe	*Evodia elleryana F. & M.*	14.86
	Pinang	*Areca catechu L.*	12.29
	Wena	*Xylopia malayana Hook.f. & Thoms.*	10.47

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Dominant plant species at Transect-3 in lowland forest at the tree level is dominated by Merbau (*Intsia bijuga*) with an IVI of 35.12 %; the pole level is dominated by Soma-soma, Kofa (*Barringtonia racemosa*) with an IVI of 37.41 %; the sapling level is dominated by Sukun hutan (*Artocarpus altilis*) with an IVI of 8.78%; and the seedling level is dominated by Palem daun halus (*Gulubia costata*) with an IVI of 22.91 %. Five tree habitus plant species with highest IVI at Transect-2 in lowland forest are presented in **Table II-62**.

Table II-60 Five Tree Habitus Plant Species with Highest IVI at the Transect-3 in Lowland Forest

Level of Growth	Local Name	Scientific Name	IVI (%)
Tree	Merbau	*Intsia bijuga A. Gray.*	35.12
	Wata, matoa	*Pometia pinnata J.R. & G. Forst.*	23.05
	Adaura	*Artocarpus teysmannii Miq.*	16.73
	Kiwibi, kiwi	*Hymenaea courbaril Linn.*	13.12
	Jabon	*Anthocephalus chinensis (Lamk.) Rich. Ex Walp.*	12.51
Pole	Soma-soma, kofa	*Barringtonia racemosa Hort. ex Miq.*	37.41
	Seri	*Glochidion lutescens Bl.*	26.42
	Watartesa, senapa, senepa, sapartesa	*Rhodamnia latifolia (Benth.) Miq.*	22.97
	Senau	*Palaquium sericeum H.J. Lam*	22.36
	Tororo, koma	*Ficus virens W. Ait.*	19.32
Sapling	Sukun hutan	*Artocarpus altilis (Parkinson) Fosberg.*	8.78
	Sp-1 T1P7	*Champereia manillana (Bl.) Merrill*	8.13
	Soma-soma, kofa	*Barringtonia racemosa Hort. ex Miq.*	7.67
	Watartesa, senapa, senepa, sapartesa	*Rhodamnia latifolia (Benth.) Miq.*	7.50
	Senau	*Palaquium sericeum H.J. Lam*	7,02
Seedling	Palem daun halus	*Gulubia costata (Becc.) Becc.*	22,91
	Kisawe, kisawai, sawi	*Pleomele angustifolia (Roxb.) N.E. Br.*	14,66
	Sp-1 T1P7	*Champereia manillana (Bl.) Merrill*	14,00
	Watartesa, senapa, senepa, sapartesa	*Rhodamnia latifolia (Benth.) Miq.*	11,27
	Damar, arowe, kibi, parada, marada	*Vatica rassak (Korth.) Bl.*	10,24

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Swamp Forest

Tree habitus dominant plant species in swamp forest at the tree and seedling levels are dominated by Watura (*Bruguirea parviflora*) with an IVI of respectively 122.02% and 113.16 %; while the pole and Sapling level of growth are dominated by Kakabora/Kakabaura (*Dolichandrone spathacea*) with an IVI of respectively 125.50 % and 64.12 %. Five tree habitus plant species with highest IVI in swamp forest at every level of growth are presented in **Table II-63**.

Table II-61 Five Tree Habitus Plant Species with Highest IVI at Various Levels of Growth at Swamp Forest in the Tangguh LNG Area

Level of Growth	Local Name	Scientific Name	IVI (%)
Tree	Watura	*Bruguirea parviflora (Roxb.) Wight. & Arn.*	122.02
	Kakabora, kakabaura	*Dolichandrone spathacea (L.f.) K. Sch.*	121.45
	Kimura, kiriri, kiropa	*Pongamia pinnata (L.) Pierre*	31.06
	Wisi, kibisi	*Inocarpus fagiferus (Parkinson) Forsb.*	6.63
	Kitis, kitisi	*Hibiscus tiliaceus L.*	6.39
Pole	Kakabora, kakabaura	*Dolichandrone spathacea (L.f.) K. Sch.*	125.50
	Watura	*Bruguirea parviflora (Roxb.) Wight. & Arn.*	77.46
	Wisi, kibisi	*Inocarpus fagiferus (Parkinson) Forsb.*	38.07
	Kimura, kiriri, kiropa	*Pongamia pinnata (L.) Pierre*	37.84
	Soma-soma, kofa	*Barringtonia racemosa Hort. ex Miq.*	21.12
sapling	Kakabora, kakabaura	*Dolichandrone spathacea (L.f.) K. Sch.*	64.12
	Kitis, kitisi	*Hibiscus tiliaceus L.*	34.79
	Wisi, kibisi	*Inocarpus fagiferus (Parkinson) Forsb.*	29.25
	Kimura, kiriri, kiropa	*Pongamia pinnata (L.) Pierre*	22.42
	Soma-soma, kofa	*Barringtonia racemosa Hort. ex Miq.*	13.66
Seedling	Watura	*Bruguirea parviflora (Roxb.) Wight. & Arn.*	113.16
	Kitis, kitisi	*Hibiscus tiliaceus L.*	46.05
	Kakabora, kakabaura	*Dolichandrone spathacea (L.f.) K. Sch.*	27.19
	Benabo	*Ficus sp.*	13.60

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Mangrove Forest

Tree habitus plant species dominating at the tree and pole levels in mangrove forest is Sapo (*Sonneratia caseolaris*) with an IVI of respectively 287.51 % and 150.80 %; while the sapling and seedling level is dominated by Weda laut (*Avicennia marina*) with an IVI of respectively 130.91 % and 124.29 %. Plant species with highest IVI in mangrove forest at the respective level of growth are presented **Table II-64**.

Table II-62 Tree Habitus Plant Species with Highest IVI at Various Levels of Growth at Mangrove Forest in the Tangguh LNG Are

Level of Growth	Local Name	Scientific Name	IVI (%)
Tree	Sapo	*Sonneratia caseolaris (L.) Engl.*	287.51
	Weda laut	*Avicennia marina (Forst.f.) Bakh.*	12.49
Pole	Sapo	*Sonneratia caseolaris (L.) Engl.*	150.80
	Weda laut	*Avicennia marina (Forst.f.) Bakh.*	149.20
Sapling	Weda laut	*Avicennia marina (Forst.f.) Bakh.*	130.91
	Watora, tonate, wabi-wabi	*Rhizophora apiculata Bl.*	44.00
	Sapo	*Sonneratia caseolaris (L.) Engl.*	25.09
Seedling	Weda laut	*Avicennia marina (Forst.f.) Bakh.*	124.29
	Sapo	*Sonneratia caseolaris (L.) Engl.*	42.29
	Watora, tonate, wabi-wabi	*Rhizophora apiculata Bl.*	33.43

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Cover crop

Types of cover crop dominating at Transect-1 in lowland forest is Grintingan (*Cynodon dactylon*) with an IVI of 37.26 %; at Transect-2 are Tesa, Wantaro, Taa, Siropa (*Taenitis blechnoides*) with an IVI of 41.41 %; and at Transect-3 is Owe-owe (*Selaginella plana*) with an IVI of 89.10 %. **Table II-65** presents five cover crop plant species with highest IVI at lowland forest ecosystem.

Table II-63 Five Cover crop Species with Highest IVI at Lowland Forest Ecosystem Type

Transect	Local Name	Scientific Name	IVI (%)
Transect-1	Grintingan	*Cynodon dactylon Pers.*	37.26
	Tesa, wantaro, taa, siropa	*Taenitis blechnoides (Willd.) Swartz.*	19.77
	Nede-nede, nida-nida	*Melastoma malabathricum Linn.*	19.75
	Pandan	*Pandanus sp.*	15.53
	Palas duri	*Licuala brevicalyx Becc.*	14.35
Transect-2	Tesa, wantaro, taa, siropa	*Taenitis blechnoides (Willd.) Swartz.*	41.41
	Nede-nede, nida-nida	*Melastoma malabathricum Linn.*	26.60
	Safe nate	*Licuala brevicalyx Becc.*	17.71
	Palem daun halus	*Gulubia costata (Becc.) Becc.*	16.75
	Pandan kecil	*Bromheadia finlaysoniana (Lindl.) Miq.*	13.78
Transect-3	Owe-owe	*Selaginella plana (Desv.) Hieron*	89.10
	Musuri	*Alpinia sp.*	51.60
	Musuri huruma	*Zingiber sp.*	23.72
	Nede-nede, nida-nida	*Melastoma malabathricum Linn.*	11.86
	Sopage	*Donax cannaeformis (G. Forst.) K. Schum.*	11.86

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project location year 2011

In the swamp forest, dominant undestory species is Pohon Pandan, Pohon Paku (*Pandanus sp*.) with an IVI of 70.37 %. While there are no cover crop species found in the mangrove forest. Five cover crop species with the highest IVI at the swamp forest ecosystem are presented in **Table II-66**.

Table II-64 Five Cover crop Species with Highest INP at Swamp Forest Ecosystem Type

Local Name	Scientific Name	IVI (%)
Pandan pohon, paku pohon	*Pandanus sp.*	70.37
Yatesa, catesa, piyai	*Acrostichum aureum L.*	53.70
Kafenisa	*Acanthus ilicifolius L.*	40.74
Firiwo	*Crinum asiaticum L.*	12.96
Kafirsa, kafirsa huruma	*Paspalum conjugatum Berg.*	11.11

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Epiphytes and Liana

In epiphytes and liana habitus, dominant plant species at Transect-1 in lowland forest are Pipi kisiri, Deda (*Mikania cordata*) with an IVI of 16.80 %; while at Transect-2 and Transect-3 is *Kagetisa daun besar/sedang* (*Rhaphidophora sylvestris*) with an IVI of respectively 27.10% and 50.01%. Five epiphytes and liana habitus plant species with the highest IVI at lowland forest ecosystem are presented in **Table II-67**.

Table II-65 Five Epiphytes and Liana Habitus Plant Species with Highest IVI at Lowland Forest Ecosystem Type

Transect	Local Name	Scientific Name	IVI (%)
Transect-1	Pipi kisiri, deda	*Mikania cordata (Burm.f.) B.L. Robinson*	16.80
	Bunga ternate	*Clitoria ternatae L.*	16.04
	Rotan T1P1-1	*Calamus aruensis Becc.*	12.69
	Rotan daun halus	*Calamus sp. 1*	11.60
	Yesirara	*Flagellaria indica L.*	11.60
Transect-2	Kagetisa daun besar/sedang	*Rhaphidophora sylvestris (Bl.) Engl.*	27.10
	Muki	*Freycinetia graminea Bl.*	18.06
	Rotan T1P1-1	*Calamus aruensis Becc.*	16.52
	Yesirara	*Flagellaria indica L.*	13.91
	Kafeta, somasio, takuri	*Entada phaseoloides (L.) Merr.*	13.50
Transect-3	Kagetisa daun besar/sedang	*Rhaphidophora sylvestris (Bl.) Engl.*	50.01
	Kagetisa daun kecil	*Pothos falcifolius Engl. & K. Krause*	31.19
	Sapo-sapo, sapara	*Ficus pumila L.*	23.10
	Rotan T1P1-1	*Calamus aruensis Becc.*	17.73
	Kafeta, somasio, takuri	*Entada phaseoloides (L.) Merr.*	11.59

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

In swamp forest, five epiphytes and liana species with the highest INP is dominated by Yesirara (*Flagellaria indica*) species with an IVI of 49.48 % and the smallest is Wadatene (*Asplenium nidus*) with an IVI of 14.22 %. Five epiphytes and liana habitus plant species in the swamp forest ecosystem with the highest INP are presented in **Table II-68**.

Table II-66 Five Epiphytes and Liana Habitus Plant Species with Highest INP at Swamp Forest Ecosystem Type

Local Name	Scientific Name	IVI (%)
Yesirara	*Flagellaria indica L.*	49.48
Kagetisa daun kecil	*Pothos falcifolius Engl. & K. Krause*	47.41
Kagetisa daun besar/sedang	*Rhaphidophora sylvestris (Bl.) Engl.*	24.91
Fiso	*Derris trifoliata Lour.*	17.74
Wadatene	*Asplenium nidus L.*	14.22

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

While in mangrove forest, epiphytes and liana plant that have the highest INP is Wadatene (*Asplenium nidus*) with an INP of 87.50 %. Five epiphytes and liana habitus plant species in mangrove forest with the highest INP are presented in **Table II-69**.

Table II-67 Epiphytes and Liana Habitus Plant Species with Highest Important Value Index at the Mangrove Forest Ecosystem Type

Local Name	Scientific Name	INP (%)
Wadatene	*Asplenium nidus L.*	87.50
Wadatene	*Lecanopteris carnosa (Reinw.) Bl.*	72.50
Wetara	*Drynaria sparsisora (Desv.) Moore*	40.00

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Distribution Pattern of Plant Species

Trees

Plant distribution patterns of tree habitus in lowland forest, swamp forest, and mangrove forest in the Tangguh LNG area are grouped and evenly, such as presented in **Table II-70**.

Table II-68 Distribution Pattern of Tree Habitus Plant Species in Various Levels of Growth at Each Forest Type in the Tangguh LNG Area

Type of Forest Ecosystem	Transect	Level of Growth	Id	Mc	Mu	Ip	Spread
Lowland Forest (Hdr)	Transect-1 (Hdr-1)	Tree	2.105	9.927	33.917	0.062	Grouped
		Pole	2.474	9.925	33.915	0.083	Grouped
		Sapling	7.474	9.916	33.906	0.363	Grouped
		Seedling	2.105	9.927	33.917	0.062	Grouped

Type of Forest Ecosystem	Transect	Level of Growth	Id	Mc	Mu	Ip	Spread
	Transect-2 (Hdr-2)	Tree	6.632	9.917	33.907	0.316	Grouped
		Pole	2.368	9.926	33.916	0.077	Grouped
		Sapling	10.474	9.915	33.905	0.528	Grouped
		Seedling	4.421	9.920	33.910	0.192	Grouped
	Transect-3 (Hdr-3)	Tree	6.857	6.639	27.109	-0.033	Evenly
		Pole	0.929	6.667	27.137	-0.006	Evenly
		Sapling	13.786	6.635	27.105	-1.078	Evenly
		Seedling	5.857	6.640	27.110	0.431	Grouped
Swamp Forest (Hr)		Tree	3.143	9.927	33.917	0.120	Grouped
		Pole	0.714	9.952	33.942	-0.016	Evenly
		Sapling	8.500	9.918	33.908	0.421	Grouped
		Seedling	0.286	9.966	33.956	-0.040	Evenly
Mangrove Forest (Hm)		Tree	5.368	9.918	33.908	0.245	Grouped
		Pole	0.714	9.952	33.942	-0.016	Evenly
		Sapling	1.842	9.929	33.919	0.047	Grouped
		Seedling	0.263	9.952	33.942	-0.041	Evenly

Cover crop

The cover crop distribution pattern at the various types of lowland forest and swamp forest in the Tangguh LNG are grouped, however in mangrove forest no significant distributions are found, as presented in **Table II-71**.

Table II-69 Distribution Pattern of the Cover crop species in Each Forest Type in Tangguh LNG Area

Type of Forest Ecosystem	Id	Mc	Mu	Ip	Distribution Type
Lowland Forest (Hdr) :					
Transect-1 (Hdr-1)	7.684	9.916	33.906	0.375	Grouped
Transect-2 (Hdr-2)	4.263	9.92	33.91	0.183	Grouped
Transect-3 (Hdr-3)	0.643	6.673	27.143	-0.031	Evenly
Swamp Forest (Hr)	2.786	9.929	33.919	0.1	Grouped
Mangrove Forest (Hm)	-	-	-	-	-

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Epiphytes and Liana

For epiphytes and liana, plant distribution patterns in various forest types at the Tangguh LNG area are grouped and evenly, as presented in **Table II-72**.

Table II-70 Distribution Pattern of Epiphytes and Liana Plant Species at Each Forest Type in Tangguh LNG Area

Type of Forest Ecosystem	Id	Mc	Mu	Ip	Distribution Pattern
Lowland Forest (Hdr) :					
Transect-1 (Hdr-1)	19.211	9.913	33.903	0.961	Grouped
Transect-2 (Hdr-2)	17.421	9.913	33.903	0.872	Grouped
Transect-3 (Hdr-3)	17.571	6.634	27.104	-1.649	Evenly
Swamp Forest (Hr)	13.714	9.915	33.905	0.874	Grouped
Mangrove Forest (Hm)	0.000	9.963	33.953	-0.056	Evenly

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Flora Diversity

Trees

The highest species diversity of the tree habitus are found in the lowland forest ecosystems. Based on the tree level of growth, this ecosystem type has the highest species diversity index on the entire tree level of growth. The Shanon diversity index of the seedling level of growth is 3.211-3.346, the sapling level is 3.431- 4.075, pole level of growth is 2.841-3.348, and tree level of growth is 2.640-3.506. The ecosystem type that has the lowest species diversity index at all tree level of growths is mangrove forest ecosystem. This indicates that the mangrove forest ecosystem in the Tangguh LNG area in 2011 is included in the poor tree vegetation types. The tree plant species diversity in the respective forest type can be observed in **Table II-73.**

Table II-71 Diversity Index of Tree Plant Species Based on Each Forest Type in the Tangguh LNG Area

Type of Forest Ecosystem	Shanon Diversity Index (H')			
	Seedling	Sapling	Pole	Tree
Lowland Forest (Hdr)				
Transect-1 (Hdr-1)	3.211	3.431	2.841	2.640
Transect-2 (Hdr-2)	3.260	3.619	3.348	3.219
Transect-3 (Hdr-3)	3.346	4.075	2.941	3.506
Swamp forest (Hr)	1.114	2.031	1.424	1.294
Mangrove Forest (Hm)	0.923	0.871	0.693	0.173

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Cover crop

For the cover crop, the highest diversity type is found in the lowland forest, i.e. 2.801; while in the mangrove forest it is a low diversity vegetation species with a zero value or no cover crop species are found (**Table II-74**).

Table II-72 Diversity Index of Cover crop species at Each Forest type in the Tangguh LNG Area

Forest Ecosystem Type	Shanon Diversity Index (H')
	Cover crop
Lowland Forest (Hdr)	
Transect-1 (Hdr-1)	2.801
Transect-2 (Hdr-2)	2.602
Transect-3 (Hdr-3)	1.465
Swamp Forest (Hr)	1.582
Mangrove Forest (Hm)	0.000

Epiphytes and Liana

For the epiphytes and liana habitus, the highest plant species diversity is found in lowland forest, namely 3.352; while the lowest is found in mangrove forest, namely 1.051. The high and low diversity levels of plant species in an area is comparable to the many or less plants found in the area. Therefore, if an area has many plant species then it will have a higher type of diversity level and vice versa. The diversity index of epiphytes and liana in Tangguh LNG areas can be observed in **Table II-75**.

Table II-73 Diversity Index of Epiphytes and Liana Species at Each Forest Species in the Tangguh LNG Area

Forest Ecosystem Type	Shanon Diversity Index (H')
	Epiphytes and Liana
Lowland forest (Hdr)	
Transect-1 (Hdr-1)	3.352
Transect-2 (Hdr-2)	2.949
Transect-3 (Hdr-3)	2.452
Swamp forest (Hr)	2.154
Mangrove forest (Hm)	1.051

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Based on the Richness of Family Numbers

In terms of the family, plant species richness found in the Tangguh LNG area in 2011 can be grouped into 111 families, which the highest number of plant species are included in the *Euphorbiaceae* family, namely 38 species. Based on the Flora Fauna Survey Report in the Tangguh LNG area, Bintuni Bay Year 2002, the plant family species found are 113 families, which the highest number of plant species are included in the *Arecaceae* family, namely 24 species; while according to the Flora Fauna Survey Report in the Tangguh LNG Project Site, Bintuni Bay Year 2007, the number of plant species families found are 110 families, in which the highest number of plant species is included in the *Euphorbiaceae* family, namely 51 species.

This information indicates that the number of plant species families found in the Tangguh LNG concession area in 2011 is less than in 2002, however it is higher than

the numbers found in 2007. The difference is due to the plant species number found in the three monitoring periods experienced differences, as described previously.

Based on the Richness of Plant Species/Habitus

The richness of plant species in the Tangguh LNG concession area in 2011 which 484 habitus species identified that can be grouped into ten habitus, namely pandanus, rattan, palm, nails, shrubs, epiphytes, herbs, liana, trees, and bamboo. Based on the spreading, the tree habitus have the highest species richness in all forest ecosystem types, i.e. respectively 94 species (lowland forest Transect-1), 135 species (lowland forest Transect-2), 137 species (lowland forest Transect-3), 28 species (swamp forest), and 3 species (mangrove forest); while in areas surrounding the basecamp the herbs habitus are 56 species. Plant species richness in every forest ecosystem type in Tangguh LNG area in 2011 based on its habitus is presented **Table II-76**.

Table II-74 Richness of Plant Species based on Habitus at Each Forest Ecosystem Type in the Tangguh LNG Area Year 2011

Plant Class	Number of Species						
	Hdr-1	Hdr-2	Hdr-3	Hr	Hm	Sbc	Total
Trees	94	135	137	28	3	24	241
Herb	23	12	9	9	0	56	81
shrub	15	10	8	3	0	34	50
Liana	23	18	23	9	0	8	40
Nails	19	17	14	6	3	4	30
Ephiphytes	6	8	8	5	0	1	13
Palm	9	5	5	1	0	3	12
Rattan	10	3	1	0	0	0	10
Pandanus	5	3	1	2	0	0	6
Bamboo	0	0	1	0	0	0	1
Total plant species	204	211	207	63	6	130	484

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

It can be observed from **Table II-76** that plant species in the Tangguh LNG concession area in 2011 is dominated by plants included in tree habitus. This indicates that the forest area condition in the area is still good. The high number of the tree habitus plant species is due to the forest area is still classified as a virgin forest and the level of disturbances to the forest such as illegal logging is relatively very low or virtually non-existent.

Based on its habitus, the richness of plant species found in the Tangguh LNG concession area in 2011 was decreasing compared to 2007, however is lhigher than the numbers found in 2002. The highest plant species richness in the three monitoring periods, are as presented in **Table II-77**.

Table II-75 Richness of Plant Species based on Surveys in 2002, 2007 and 2011

Habit	Number of Types			
	2002	2007	2011	Total
Identified:				
Bamboo	0	1	1	2
Epiphytes	23	77	13	72
Herb	13	106	81	187
Liana	68	125	40	128
Moss	0	1	0	1
Nails	101	31	30	67
Palm	0	14	12	22
Pandanus	0	4	6	8
Shrub	0	46	50	84
tress	211	509	241	584
Rattan	0	8	10	12
Total identified types	**416**	**922**	**484**	**1.166**
Total non-identified types	**0**	**119**	**0**	**245**
Total plant types	**416**	**1,041**	**484**	**1,411**

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project location year 2011

Above information indicates that the habitus number of the plant species found in the Tangguh LNG concession area in 2011 is less than in 2007, however higher than the numbers found in 2002. The difference is due to the plant species number found in the three monitoring periods differs, as described previously.

Based on the Richness of Protection and Scarcity Status of Flora Species

Plant species found in the Tangguh LNG conservation areas in 2011 protected by Government Regulation No. 7 Year 1999 is one species and included in the CITES List Appendix II are nine species. The plant species found in the Tangguh LNG area in 2011 included in the IUCN red list are 16 namely eight species are included in the LC/Least Concern category, one species in the NT/Near Threatened category, six species in the VU/Vulnerable category and one species in EN/Endangered category. The list of plant species based on the plant status in the Tangguh LNG area in 2011 presented in **Table II-78**.

Table II-76 Plant Species Richness Based on Plant Status in Each Forest Ecosystem Type in the Tangguh LNG Area Year 2011

No.	Scientific Name	Local Name	Location	Plant Status		
				PP	CITES	IUCN
1	*Agathis labilardieri Warb.*	Damar	Hdr-2	TD	TT	LC
2	*Aquilaria filaria (Oken.) Merrill*	Gaharu	Hdr-3	TD	App. II	TT
3	*Bromheadia finlaysoniana (Lindl.) Miq.*	Pandan kecil	Hdr-1, Hdr-2	TD	App. II	TT
4	*Bulbophyllum sp.*	Anggrek putih	Hr	Un.	App. II	Un.

No.	Scientific Name	Local Name	Location	Plant Status		
				PP	CITES	IUCN
5	*Calophyllum insularum P.F. Stevens.*	Bintangur daun halus	Hdr-1, Hdr-2, Hdr-3	TD	TT	EN B1+2c
6	*Cyathea latebrosa (Wall.) Copel.*	Tegabe	Hdr-1, Hdr-2, Hdr-3	TD	App. II	TT
7	*Cyathea lurida (Bl.) Copel.*	Tegabe	Hdr-1	TD	App. II	TT
8	*Flindersia laevicarpa White & Francis*	Tiang-1 T3P6	Hdr-2, Hdr-3	TD	TT	VU
9	*Gonystylus macrophyllus (Miq.) Airy Shaw*	Yebi-yebi	Hdr-1, Hdr-2	TD	App. II	VU
10	*Grammatophyllum speciosum Bl.*	Anggrek kuning	Hdr-1, Sbc	D	App. II	TT
11	*Horsfieldia irya (Gaertn.) Warb.*	Firoro, nete-nete	Hdr-1, Hdr-3	TD	TT	LC
12	*Instia acuminata Merrill*	Merbau	Hdr-3	TD	TT	VU
13	*Intsia bijuga A. Gray.*	Merbau	Hdr-1, Hdr-2, Hdr-3	TD	TT	VU
14	*Myristica cf. lancifolia Merrill*	Nate, nesaro	Hdr-1, Hdr-2, Hdr-3	TD	TT	VU
15	*Myristica globosa Warb.*	Sp5-T1P4	Hdr1, Hdr-2	TD	TT	NT
16	*Nageia wallichiana (Presl.) O. Kuntze.*	Kayu cina	Hdr-3	TD	TT	LC
17	*Pericopsis mooniana Thwaites*	Pohon-3 T3P8	Hdr-2 Hdr-3	TD	TT	VU
18	*Pholidota chinensis Lindl.*	Anggrek bonggol	Hdr-2	TD	App. II	TT
19	*Rhizophora apiculata Bl.*	Watora, tonate, wabi-wabi	Hm	TD	TT	LC
20	*Santiria apiculata A.W. Benn.*	Keda	Hdr-1	TD	TT	LC
21	*Santiria griffithii Engl.*	Wakore	Hdr-1, Hdr-2, Hdr-3	TD	TT	LC
22	*Santiria laevigata Blume*	Wakore	Hdr-3	TD	TT	LC
23	*Spathoglottis plicata Bl.*	Anggrek tanah	Hdr-1, Hdr-2, Hdr-3	TD	App. II	TT
24	*Vatica rassak (Korth.) Bl.*	Damar, arowe, kibi, parada, marada	Hdr-2, Hdr-3	TD	TT	LC

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Remarks:

PP= Government Regulation No. 7 Year 1999; CITES = Convention on International Trade in Endangered Species of Wild Fauna and Flora Appendix, IUCN (International Union for Conservation of Nature and Natural Resources) ver 2.3 of 2010

Habitat: Hdr-1= Lowland forest Transect 1, Hdr-2= Lowland forest Transect 2, Hdr-3= Lowland forest Transect 3, Hr= Swamp forest, Hm= Mangrove forest, Sbc= Surrounding basecamp

Plant Status: EN= Endangered, VU= Vulnerable, Low risk NT= Near Threatened, LC= Least concerned, D= Protected, TD= Not protected, App.= Appendix, TT= Not registered, Un.= Undeterminated.

Plant species based on the plant status found in the Tangguh LNG concession area in 2002, 2007 and 2011 entirely are as follows: 3 plants were found as the protected species under Government Regulation No. 7 Year 1999, 45 plants were identified as the species listed in the CITES List Appendix II and 27 plants were listed as the species of the IUCN red list. In terms of the period of monitoring, richness of plant species found in the Tangguh LNG concession area in 2011 that are protected in accordance with Government Regulation No. 7 Year 1999 and included in the CITES List Appendix II are less than the number of species found in 2002 and 2007 survey; whereas the plant species found in 2011 included in IUCN red list are higher than the number of species found in 2002 survey, but the same result from 2007 survey, as presented in **Table II-79**.

Table II-77 Plant Species Richness Based on Plant Status According to Surveys in 2002, 2007, and 2011

Plant Status	Number of Types			
	2002	2007	2011	Total
Protected under Government Regulation No. 7 Year 1999	2	2	1	3
CITES :				
Appendix I	0	0	0	0
Appendix II	16	30	9	45
Appendix III	0	0	0	0
IUCN :				
LC/*Least Concern*	4	10	8	13
NT/*Near Threatened*	2	1	1	3
VU/*Vulnerable*	6	4	6	10
EN/*Endangered*	1	1	1	1

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Potential Stand /Plant

Highest Potential wood in the Tangguh LNG areas are in the lowland forest, i.e. 296.24 m^3/ha, while the lowest are in the mangrove forest, i.e. 24.31m^3/ha. Potential wood volume of various forest ecosystem types in the Tangguh LNG areas are presented in **Table II-80**.

Table II-78 Potential Wood Volume of Various Forest Ecosystem Types in the Tangguh LNG Areas

Forest Ecosystem Types	Wood Volume (m^3/ha)					
	10-19	20-29	30-39	40-49	50 up	Total
Lowland forest (Hdr) :						
Transect-1 (Hdr-1)	17.04	18.68	8.35	5.51	30.58	80.16
Transect-2 (Hdr-2)	21.96	57.47	22.64	7.69	163.40	273.15
Transect-3 (Hdr-3)	11.58	11.64	23.95	15.26	233.80	296.24
Hdr Average	16.86	29.26	18.31	9.49	142.59	216.52

Swamp forest (Hr)	14.58	9.11	13.77	16.62	31.25	85.33
Mangrove forest (Hm)	2.50	4.75	7.73	3.51	5.82	24.31

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Value of Plant Utilization

Based on interviews with community in the surroundings of Tangguh LNG forest areas, field observations and literature studies indicated that there were 154 species of plants that have utilization values and can be used for 21 utilization purposes. The highest utilization as medicinal plants are 137 species, while the lowest utilization are respectively one plant species used as material for chewing and gum producing plant. Plant utilization groups in the Tangguh LNG areas can be seen in **Table II-81**.

Table II-79 Plant Utilization Group in Tangguh LNG Forest in Tangguh LNG Areas

No.	Utilization Groups	Number of Species
1.	Medicinal Plants	137
2.	Ornamental Plants	28
3.	Food Producing Plants	18
4.	Aromatic Plants	2
5.	Root and Tuber Producing Plants	5
6.	Fuel Producing Plants	2
7.	Dye Material Producing Plants	5
8.	Chew Material Producing Plants	1
9.	Gum Producing Plants	2
10.	Plants Producing Sugar, Alcohol or Acid	3
11.	Plants Producing Gum	1
12.	Plants Producing Oil and Vegetable Fat	2
13.	Plants Producing Essential Oils	2
14.	Plants Producing Animal Feed	13
15.	Plants Producing Toxins, including Insecticides	8
16.	Plants Producing Spices and Herbs	4
17.	Plants Producing Resin	1
18.	Plants Producing Fibers	5
19.	Plants Producing Tannin	1
20.	Plants Producing Wax	1
21.	Plants Producing Rope and Plait Materials	11
Total plant species		**190**

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

2.2.1.2 Terrestrial Fauna

The following description is based on the results of fauna survey that has been performed for five months, i.e starting in September 2011 and ending in January 2012.

Mammals

Based on ANDAL Study in 2002, the Flora Fauna Survey in the Tangguh LNG Project Site in 2007 as well as the Flora and Fauna Monitoring Survey in the Tangguh LNG in 2011 that have been performed in the Tangguh LNG Buffer Zone, there were found 25 species of mammals fauna in the observation location. In detail, fauna species observation results of mammals group in the Tangguh LNG areas based on three surveys presented in **Table II-82**.

Table II-80 Mammals in the Observation Location of the Tangguh LNG Based on Surveys in 2002, 2007 and 2011

Species	Year of Observation		
	2002	2007	2011
Megachiroptera			
Dobsonia minor (Dobson, 1879)	-	+	+
Dobsonia magna Thomas, 1905	-	+	-
Syconycteris australis (Peters, 1867)	-	+	+
Nyctimene albiventer (Gray, 1867)	+	+	+
Macroglossus minimus (Geoffroy, 1810)	+	+	+
Nyctimene aello (Thomas, 1900)	-	+	+
Paranyctimene raptor Tate, 1942	-	+	+
Pteropus macrotis (Peters, 1867)	-	+	+
Microchiroptera			
Hipposideros diadema (Geoffroy, 1813)	-	+	+
Nyctophilus sp.	-	+	-
Saccolaimus saccolaimus (Temminck, 1838)	-	+	-
Murina florium Thomas, 1908	-	-	+
Rodentia			
Rattus praetor (Thomas, 1888)	-	+	-
Rattus leucopus (Gray, 1867)	-	-	+
Rattus tanezumi Temminck, 1844	+	+	+
Hydromys chrysogaster E. Geoffroy, 1804	-	+	-
Paramelomys platyops (Thomas, 1911)		+	-
Paramelomys naso Thomas, 1922		+	-
Marsupialia			
Myoictis melas (Muller, 1840)	+		
Spilocuscus maculatus (Desmarest, 1818)	+		
Pseudochirulus canescens (Waterhouse, 1846)	+		
Mapurus breviceps Waterhouse, 1838	-	+	-
Strigocuscus gymnotis (Peters&Doria, 1875)	-	+	-

Species	Year of Observation		
	2002	2007	2011
Echymipera clara Stein, 1932	-	+	-
Echymipera kalubu (Lesson, 1828)	-	+	-

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

The data of mammal species from 2002 to 2011 indicates that the disclosure of mammal species that possibly exist in Tangguh LNG's Buffer Zone Area has not been maximal. Survey reports in the Tangguh LNG area in 2002 records that there are no less than 20 species of *Marsupialia*; 13 species of *Rodentia*; 12 species of *Megachiroptera*; and 29 species of *Microchiroptera*, that are estimated to inhabit the buffer forest of the Tangguh LNG.

Apart from the buffer zone of the Tangguh LNG, observations were also performed in the Tangguh LNG areas. A total of five mammal species were found in the Tangguh LNG Areas, in various locations. A list of mammal species found in the Tangguh LNG Area presented in

Table II-81 Types of Mammals Found in the Tangguh LNG Site

Type	Mess	Workplace / Workshop	Yards / Grasslands
Cervus timorensis (Deer)	-	-	+
Sus scrofa (Wild Boar)	-	-	+
Felis domesticus (Cat)	+	+	+
Canis Familiaris (Dog)	+	+	+
Rattus tanezumi (Oriental House rat)	+	+	+

Source : Flora and Fauna Survey Result Report at Tangguh LNG Project Site Year 2011

Based on all types of mammals found in the Tangguh LNG Areas either in the Tangguh LNG Areas as well as the buffer zones, there is only one species of protected mammals which is Deer (*Cervus timorensis*). Deers are protected based on Government Regulation No. 7 Year 1999 regarding Preservation of Flora and Fauna Species which its status is vulnerable to extinction based on IUCN Red List. Although these are protected mammals and have the vulnerable status, deers are not native mammals of the Papua Island but have been introduced from outside Papua.

Birds

Referring to four surveys performed in the Tangguh LNG Areas, namely surveys in 2001, 2002, 2007 and 2011, 250 bird species were found, in detail, 120 species were found in 2001 survey, 122 species in 2002 survey, 108 species in 2007 survey and 142 species in 2011 survey. The list of bird species based on the four surveys presented **Table II-84.**

Table II-82 List of Bird Species in the Observation Location of the Tangguh LNG Area

No.	Order/Family/Species	Indonesian Name	Existing Species in Year:			
			2001	2002	2007	2011
ANSERIFORMES						
Anatidae						
1	*Nettapus coromandelianus Gmelin, 1789*	Trutu hijau	√			
2	*Tadorna radjah Lesson, 1828*	Umukia raja	√	√		√
APODIFORMES						
Apodidae						
3	*Aerodramus vanikorensis Quoy & Gaimard, 1830*	Walet polos	√	√		
4	*Collocalia esculenta Linnaeus, 1758*	Walet sapi	√		√	√
5	*Hirundapus caudacutus Latham, 1802*	Kapinis-jarum asia		√		
6	*Mearnsia novaeguineae D'Albertis & Salvadori, 1879*	Kapinisjarum papua	√			√
Hemiprocnidae						
7	*Hemiprocne mystacea Lesson, 1827*	Tepekong jambul	√	√		√
CAPRIMULGIFORMES						
Caprimulgidae						
8	*Caprimulgus indicus Latham, 1790*	Cabak kelabu	√			
9	*Caprimulgus macrurus Horsfield, 1821*	Cabak maling		√		
Podargidae						
10	*Aegotheles bennettii Salvadori & D'Albertis, 1875*	Atoku maluku	√			
11	*Podargus ocellatus Quoy & Gaimard, 1830*	Paruhkodok pualam		√	√	√
12	*Podargus papuensis Quoy & Gaimard, 1830*	Paruhkodok papua	√		√	√
CHARADRIIFORMES						
Charadriidae						
13	*Charadrius leschenaultii Lesson, 1826*	Cerekpasir besar			√	√
14	*Charadrius mongolus Pallas, 1776*	Cerekpasir mongolia				√
15	*Pluvialis squatorola Linnaeus, 1758*	Cerek besar			√	√
Haematopodidae						
16	*Haematopus longirostris Vieillot, 1817*	Kedidir belang	√			
Laridae						
17	*Anous minutus Boie, 1844*	Camar-angguk hitam	√		√	
18	*Chlidonias leucopterus Temminck, 1815*	Dara-laut sayap-putih	√			√
19	*Gelochelidon nilotica Gmelin, 1789*	Camar tiram		√		
20	*Gygis alba Sparrman, 1786*	Camar-putih mata-cincin	√			
21	*Sterna albifrons Pallas, 1764*	Dara-laut kecil	√			
22	*Sterna bergii Lichtenstein, 1823*	Dara-laut jambul				√
23	*Sterna fuscata Linnaeus, 1766*	Dara-laut sayap-hitam			√	√
24	*Sterna hirundo Linnaeus, 1758*	Dara-laut biasa	√			√

No.	Order/Family/Species	Indonesian Name	Existing Species in Year:			
			2001	2002	2007	2011
25	*Sterna sumatrana Raffles, 1822*	Dara-laut tengkuk-hitam	√			
	Scolopacidae					
26	*Actitis hypoleucos Linnaeus, 1758*	Trinil pantai	√	√		√
27	*Calidris tenuirostris Horsfield, 1821*	Kedidi besar				√
28	*Heteroscelus brevipes Vieillot, 1816*	Trinil ekor-kelabu	√			
29	*Heteroscelus incanus Gmelin, 1789*	Trinil penjelajah	√			
30	*Numenius phaeopus Linnaeus, 1758*	Gajahan penggala	√			√
31	*Tringa nebularia Gunnerus, 1767*	Trinil betis hijau		√		
	CICONIIFORMES					
	Ardeidae					
32	*Ardea pacifica Latham, 1801*	Cangak pasifik	√			
33	*Ardea picata Gould, 1845*	Kuntul belang	√			
34	*Ardea sumatrana Raffles, 1822*	Cangkak laut	√		√	
35	*Bubulcus ibis Linnaeus, 1758*	Kuntul kerbau			√	
36	*Butorides striatus Linnaeus, 1758*	Kokokan laut	√	√	√	√
37	*Casmerodius albus Linnaeus, 1758*	Cangak-besar erasia	√			
38	*Egretta garzetta Linnaeus, 1766*	Kuntul kecil	√		√	√
39	*Egretta novaehollandiae Latham, 1790*	Cangak australia	√			
40	*Egretta sacra Gmelin, 1789*	Kuntul karang	√	√	√	
41	*Ixobrychus flavicollis Latham, 1790*	Bambangan hitam	√	√	√	√
42	*Ixobrychus sinensis Gmelin, 1789*	Bambangan kuning			√	
43	*Mesophoyx intermedia Wagler, 1827*	Kuntul perak			√	
44	*Nycticorax caledonicus Gmelin, 1789*	Kowakmalam merah		√	√	√
45	*Zonerodius heliosylus Lesson & Garnot, 1828*	Bambangan rimba			√	
	Threskiornithidae					
46	*Platalea regia Gould, 1838*	Ibis-sendok raja		√		
47	*Threskiornis molucca Cuvier, 1829*	Ibis australia	√	√		
48	*Threskiornis spinicollis Jameson, 1835*	Ibis papua			√	
	COLUMBIFORMES					
	Columbidae					
49	*Chalcophaps indica Linnaeus, 1758*	Delimukan zamrud			√	√
50	*Chalcophaps stephani Pucheran, 1853*	Delimukan timur		√	√	√
51	*Columba vitiensis Quoy & Gaimard, 1830*	Merpatihutan metalik				√
52	*Ducula bicolor Scopoli, 1786*	Pergam laut			√	
53	*Ducula mullerii Temminck, 1835*	Pergam kalung	√			√
54	*Ducula pinon Quoy & Gaimard, 1824*	Pergam pinon	√	√	√	√
55	*Ducula rufigaster Quoy & Gaimard, 1830*	Pergam ekor-ungu	√	√		√
56	*Ducula zoeae Lesson, 1826*	Pergam zoe		√	√	√
57	*Gallicolumba rufigula Pucheran, 1853*	Delimukan pomo	√			
58	*Geopelia humeralis Temminck., 1821*	Perkutut australia	√			
59	*Goura cristata Pallas, 1764*	Mambruk biasa	√		√	

No.	Order/Family/Species	Indonesian Name	Existing Species in Year:			
			2001	2002	2007	2011
60	*Gymnophaps albertisii Salvadori, 1874*	Merpati-gunung irian	√			
61	*Macropygia amboinensis Linnaeus, 1766*	Uncal amban	√	√		√
62	*Macropygia nigrirostris Salvadori, 1875*	Uncal paruh-hitam			√	√
63	*Ptilinopus aurantiifrons Gray, 1858*	Walik dahi-jingga	√	√	√	√
64	*Ptilinopus coronulatus Gray, 1858*	Walik lunggung	√	√		√
65	*Ptilinopus iozonus Gray, 1858*	Walik perut-jingga		√	√	√
66	*Ptilinopus magnificus Temminck, 1821*	Walik wompu		√		√
67	*Ptilinopus naina Temminck, 1835*	Walik kerdil	√	√		
68	*Ptilinopus ornatus Schlegel, 1871*	Walik buma		√		
69	*Ptilinopus perlatus Temminck, 1835*	Walik mutiara		√		
70	*Ptilinopus pulchellus Temminck, 1835*	Walik elok			√	
71	*Ptilinopus superbus Temminck, 1809*	Walik raja		√	√	
72	*Reinwardtoena reinwardtii Temminck, 1824*	Uncal besar		√	√	
CORACIIFORMES						
Alcedinidae						
73	*Alcedo azurea Latham, 1801*	Rajaudang biru-langit	√			√
74	*Alcedo pusilla Temminck, 1836*	Rajaudang kecil		√		√
75	*Ceyx lepidus Temminck, 1836*	Udangmerah kerdil		√	√	√
76	*Clytoceyx rex Sharpe, 1880*	Rajaudang paruh-sekop	√			√
77	*Dacelo gaudichaud Quoy & Gaimard, 1824*	Kukabura perut-merah	√	√	√	√
78	*Dacelo leachii Vigors & Horsfield, 1826*	Kukabura sayap-biru				√
79	*Melidora macorrhina Lesson, 1827*	Rajaudang paruh-kait			√	
80	*Melidora macrorrhina Lesson, 1827*	Rajaudang paruh-kait		√		√
81	*Syma torotoro Lesson, 1827*	Cekakak torotoro		√	√	√
82	*Tanysiptera galatea Gray, 1859*	Cekakakpita biasa	√	√	√	√
83	*Tanysiptera nympha Gray, 1840*	Cekakakpita bidadari				√
84	*Todiramphus chloris Boddaert, 1783*	Cekakak sungai	√	√	√	√
85	*Todiramphus macleayii Jardine & Selby, 1830*	Cekakak rimba			√	√
86	*Todiramphus nigrocyaneus Wallace, 1862*	Cekakak biru-hitam		√		√
87	*Todiramphus sanctus Vigors & Horsfeld, 1827*	Cekakak australia	√	√	√	√
88	*Rhyticeros plicatus Forster, 1781*	Julang papua	√	√	√	√
Coraciidae						
89	*Eurystomus orientalis Linnaeus, 1766*	Tionglampu biasa	√	√	√	√
Meropidae						
90	*Merops ornatus Latham, 1801*	Kirikkirik australia		√	√	√
CUCULIFORMES						
Cuculidae						

No.	Order/Family/Species	Indonesian Name	Existing Species in Year:			
			2001	2002	2007	2011
91	*Cacomantis variolosus Vigors & Horsfield, 1826*	Wiwik rimba		√		√
92	*Caliechthrus leucolophus Müller, 1840*	Kedasi topi-putih		√		√
93	*Centropus bernsteini Schlegel, 1866*	Bubut hitam			√	√
94	*Centropus menbeki Lesson & Garnot, 1828*	Bubut pini		√		√
95	*Centropus phasianinus Latham, 1801*	Bubut ayam				√
96	*Chrysococcyx lucidus Gmelin, 1788*	Kedasi emas			√	
97	*Cuculus saturatus Blyth, 1843*	Kangkok ranting		√		
98	*Eudynamys cyanocephala Latham, 1802*	Tuwur australia		√		
99	*Eudynamys scolopaceus Linnaeus, 1758*	Tuwur asia			√	√
100	*Microdynamis parva Salvadori, 1875*	Tuwur kerdil		√		√
101	*Scythrops novaehollandiae Latham, 1790*	Karakalo australia	√			√
FALCONIFORMES						
Accipitridae						
102	*Accipiter cirrocephalus Vieillot, 1817*	Elangalap kalung		√	√	
103	*Accipiter fasciatus Vigors & Horsfield, 1827*	Elangalap coklat				√
104	*Accipiter novaehollandiae Gmelin, 1788*	Elangalap kelabu	√			√
105	*Accipiter poliocephalus Gray, 1858*	Elangalap pucat-sosonokan	√		√	√
106	*Aquila gurneyi Gray, 1860*	Rajawali kuskus	√			
107	*Aviceda subcristata Gould, 1838*	Alap-alap kukuk	√	√	√	
108	*Haliaeetus leucogaster Gmelin, 1788*	Elanglaut perut-putih	√	√		√
109	*Haliastur indus Boddaert, 1783*	Elang bondol	√	√	√	√
110	*Haliastur sphenurus Vieillot, 1818*	Elang siul	√			
111	*Henicopernis longicauda Garnot, 1828*	Elang ekor-panjang	√			
112	*Hieraaetus morphnoides Gould, 1841*	Elang kecil		√		
113	*Pandion haliaetus Linnaeus, 1758*	Elang tiram	√	√		√
GALLIFORMES						
Megapodiidae						
114	*Megapodius freycinet Gaimard, 1823*	Gosong kelam			√	√
115	*Talegalla fuscirostris Salvadori, 1877*	Maleo paruh-hitam		√	√	√
116	*Talegalla jobiensis Meyer, 1874*	Maleo kerah-coklat			√	
Phasianidae						
117	*Coturnix ypsilophora Bosc, 1792*	Puyuh coklat			√	√
GRUIFORMES						
Rallidae						
118	*Eulabeornis castaneoventris Gould, 1844*	Mandar bakau			√	√
119	*Gallinula tenebrosa Gould, 1846*	Mandar kelam	√		√	
120	*Gallirallus philippensis Linnaeus, 1766*	Mandarpadi kalung-kuning			√	√
121	*Porphyrio porphyrio Linnaeus, 1758*	Mandar besar				√
122	*Rallina tricolor Gray, 1858*	Tikusan tukar			√	√

No.	Order/Family/Species	Indonesian Name	Existing Species in Year:			
			2001	2002	2007	2011
PASSERIFORMES						
Acanthizidae						
123	*Crateroscelis murina Sclater, 1858*	Tepus-tikus merah		√		
124	*Gerygone chloronota Gould, 1843*	Remetuk tunggir-hijau		√		√
125	*Gerygone chrysogaster Gray, 1858*	Remetuk perut-emas		√		√
126	*Gerygone levigaster Gould, 1843*	Remetuk bakau	√			√
127	*Gerygone magnirostris Gould, 1843*	Remetuk rawa		√		
128	*Sericornis beccarii Salvadori, 1874*	Sericornis kecil				√
129	*Sericornis rufescens Salvadori, 1876*	Sericornis vogelkop				√
Campephagidae						
130	*Campochaera sloetii Schlegel, 1866*	Kepudang-sungu emas		√		
131	*Coracina boyeri Gray, 1846*	Kepudangsungu kelek-coklat	√	√		√
132	*Coracina caeruleogrisea Gray, 1858*	Kepudang-sungu paruh-tebal	√			
133	*Coracina melas Lesson, 1828*	Kepudangsungu hitam		√	√	√
134	*Coracina papuensis Gmelin, 1788*	Kepudang-sungu kartula	√	√		
135	*Coracina schisticeps Gray, 1846*	Kepudang-sungu desin			√	
136	*Coracina tenuirostris Jardine,1831*	Kepudangsungu miniak			√	√
137	*Lalage atrovirens Gray, 1862*	Kapasan alis-hitam		√	√	√
138	*Lalage leucomela Vigors & Horsfield, 1827*	Kapasan alis-putih	√		√	√
139	*Lalage sueurii Vieillot, 1818*	Kapasan sayap-putih				√
Colluricinclidae						
140	*Colluricincla megarhyncha Quoy & Gaimard, 1830*	Anis-bentet kecil		√		
Corvidae						
141	*Corvus orru Bonaparte, 1851*	Gagak orru	√	√	√	√
142	*Corvus tristis Lesson & Garnot, 1827*	Gagak kelabu		√		
PASSERIFORMES						
Cracticidae						
143	*Cracticus cassicus Boddaert, 1783*	Jagal papua		√		√
144	*Cracticus quoyi Lesson, 1827*	Jagal hitam		√	√	
Dicaeidae						
145	*Dicaeum pectorale Müller, 1843*	Cabai papua	√	√	√	√
Dicruridae						
146	*Dicrurus bracteatus Gould, 1842*	Srigunting jambul-rambut	√	√		
147	*Dicrurus hottentottus Linnaeus, 1766*	Srigunting jambul-rambut			√	√

No.	Order/Family/Species	Indonesian Name	Existing Species in Year:			
			2001	2002	2007	2011
Estrildidae						
148	*Lonchura castaneothorax Gould, 1837*	Bondol dada-coklat	√			
Hirundinidae						
149	*Hirundo rustica Linnaeus, 1758*	Layang-layang asia		√		√
Laniidae						
150	*Lanius cristatus Linnaeus, 1758*	Bentet coklat	√			
Maluridae						
151	*Malurus alboscapulatus Meyer, 1874*	Cikrak-peri bahu-putih	√	√		√
152	*Malurus cyanocephalus Quoy & Gaimard, 1830*	Cikrak-peri kaisar		√	√	√
Melanocharitidae						
153	*Melanocharis nigra Lesson, 1830*	Burung-buah hitam	√	√		
154	*Oedistoma iliolophum Salvadori, 1876*	Cucuk-panjang kate	√			
155	*Oedistoma pygmaeum Salvadori, 1876*	Cucuk-panjang kerdil		√		
Meliphagidae						
156	*Conopophila albogularis Gould, 1843*	Isapmadu kalung-coklat				√
157	*Lichenostomus versicolor Gould, 1843*	Isapmadu kepodang		√		√
158	*Melilestes megarhynchus Gray, 1858*	Isapmadu paruhpanjang		√	√	√
159	*Meliphaga albonotata Salvadori, 1876*	Meliphaga semak	√			
160	*Meliphaga aruensis Sharpe, 1884*	Meliphaga aru			√	√
161	*Meliphaga gracilis Gould, 1866*	Meliphaga anggun			√	√
162	*Meliphaga mimikae Ogilvie-Grant, 1911*	Meliphaga mimika	√			
163	*Meliphaga montana Salvadori, 1880*	Meliphaga rimba				√
164	*Meliphaga orientalis Meyer, 1894*	Meliphaga gunung	√			
165	*Myzomela eques Lesson & Garnot, 1827*	Burung-madu myzomela eques		√		
166	*Myzomela obscura Gould, 1843*	Myzomela remang		√	√	√
167	*Philemon buceroides Swainson, 1838*	Cikukua tanduk			√	√
168	*Philemon meyeri Salvadori, 1875*	Cikukua kerdil	√	√		
169	*Philemon novaeguineae Müller, 1843*	Burung-madu besar irian	√	√		
170	*Pycnopygius ixoides Salvadori, 1878*	Isap-madu polos	√			
171	*Pycnopygius stictocephalus Salvadori, 1876*	Isap-madu kepala-coreng	√			
172	*Timeliopsis griseigula Schlegel, 1871*	Cucuklurus coklat				√
173	*Toxorhamphus novaeguineae Lesson, 1827*	Cucukpanjang perut-kuning		√		√
174	*Xanthotis chrysotis Lesson & Garnot, 1828*	Isap-madu dada-coklat		√		
175	*Xanthotis flaviventer Lesson, 1828*	Isapmadu dada-coklat			√	√

No.	Order/Family/Species	Indonesian Name	Existing Species in Year:			
			2001	2002	2007	2011
Monarchidae						
176	*Arses telescophthalmus Garnot, 1827*	Kehicap biku-biku	√	√		
177	*Monarcha chrysomela Garnot, 1827*	Kehicap emas		√		√
178	*Monarcha guttulus Garnot, 1829*	Kehicap tutul				√
179	*Monarcha manadensis Quoy & Gaimard, 1830*	Kehicap bertopi				√
180	*Myiagra alecto Temminck, 1827*	Sikatan kilap	√	√		
Motacillidae						
181	*Anthus novaeseelandiae Gmelin, 1789*	Apung tanah	√			
182	*Motacilla flava Linnaeus, 1758*	Kicuit kerbau				√
Nectariniidae						
183	*Cinnyris jugularis Linnaeus, 1766*	Burungmadu sriganti				√
184	*Nectarinia aspasia Lesson & Garnot, 1828*	Burung-madu hitam	√	√	√	√
185	*Nectarinia jugularis Linnaeus, 1766*	Burung-madu sriganti	√	√	√	
Oriolidae						
186	*Oriolus szalayi Madarász, 1900*	Kepudang coklat	√	√	√	√
Orthonychidae						
187	*Ptilorrhoa caerulescens Temminck, 1835*	Tepuspermata biru	√			√
Pachycephalidae						
188	*Pachycephala simplex Gould, 1843*	Kancilan kelabu		√		√
189	*Pitohui ferrugineus Bonaparte, 1850*	Pitohui karat	√	√	√	√
190	*Pitohui kirhocephalus Lesson & Garnot, 1827*	Pitohui belang	√	√	√	√
191	*Pitohui sp.*	Pitohui			√	
Paradisaeidae						
192	*Cicinnurus regius Linnaeus, 1758*	Cenderawasih raja		√		
193	*Manucodia ater Lesson, 1830*	Manucodia kilap		√	√	
194	*Manucodia keraudrenii Lesson & Garnot, 1826*	Manukodia terompet			√	
195	*Paradisaea minor Shaw, 1809*	Cenderawasih kecil	√	√	√	√
196	*Ptiloris magnificus Vieillot, 1819*	Toowa cemerlang		√		
197	*Seleucidis melanoleucus Daudin, 1800*	Cendrawasih duabelas kawat		√		
Petroicidae						
198	*Microeca flavigaster Gould, 1843*	Sikatan perut-kuning				√
199	*Microeca flavovirescens Gray, 1858*	Sikatan zaitun		√		√
200	*Monachella muelleriana Schlegel, 1871*	Sikatan sungai	√			
201	*Peneoenanthe pulverulenta Bonaparte, 1850*	Robin bakau				√
202	*Poecilodryas hypoleuca Gray, 1859*	Robin belang		√		
Pittidae						
203	*Pitta erythrogaster Temminck, 1823*	Paok mopo		√		√
204	*Pitta sordida Müller, 1776*	Paok hijau		√	√	√

No.	Order/Family/Species	Indonesian Name	Existing Species in Year:			
			2001	2002	2007	2011
	Ploceidae					
205	*Passer domesticus Linnaeus, 1758*	Burung-gereja rumah				√
	Pomatostomidae					
206	*Pomatostomus isidorei Lesson, 1827*	Cicapapua merah		√	√	√
	Ptilonorhynchidae					
207	*Ailuroedus buccoides Temminck, 1835*	Burung-kucing telinga putih	√		√	
208	*Chlamydera cerviniventris Gould, 1850*	Namdur coklat	√			
	Rhipiduridae					
209	*Rhipidura albolimbata Salvadori, 1874*	Kipasan dagu-putih			√	
210	*Rhipidura hyperythra Gray, 1858*	Kipasan perut-coklat			√	√
211	*Rhipidura leucophrys Latham, 1801*	Kipasan kebun	√	√	√	√
212	*Rhipidura leucothorax Salvadori, 1874*	Kipasan-semak perut-putih	√	√		
213	*Rhipidura maculipectus Gray, 1858*	Kipasan-semak hitam		√	√	√
214	*Rhipidura rufidorsa Meyer, 1874*	Kipasan tunggir-merah		√		
215	*Rhipidura rufifrons Latham, 1801*	Kipasan dada-hitam	√			
216	*Rhipidura rufiventris Vieillot, 1818*	Kipasan dada-lurik		√	√	√
217	*Rhipidura threnothorax Müller, 1843*	Kipasan-semak bayan		√		√
	Sturnidae					
218	*Aplonis cantoroides Gray, 1862*	Perling kicau	√			√
219	*Aplonis metallica Temminck, 1824*	Perling ungu	√		√	
220	*Mino anais Lesson, 1839*	Mino emas	√	√	√	
221	*Mino dumontii Lesson, 1827*	Mino muka-kuning	√	√	√	
	Sylviidae					
222	*Acrocephalus orientalis Temminck & Schlegel, 1847*	Kerakbasi besar	√			
223	*Acrocephalus stentoreus Ehrenberg, 1833*	Kerakbasi ramai	√			
224	*Cisticola exilis Vigors & Horsfield, 1827*	Cici merah	√			
	PELECANIFORMES					
	Fregatidae					
225	*Fregata ariel Gray, 1845*	Cikalang kecil	√		√	
226	*Fregata minor Gmelin, 1789*	Cikalang besar	√			
227	*Phalacrocorax melanoleucos Vieillot, 1817*	Pecuk padi belang	√			
	PSITTACIFORMES					
	Psittacidae					
228	*Alisterus amboinensis Linnaeus, 1766*	Nuri-raja ambon	√	√		
229	*Cacatua galerita Latham, 1790*	Kakatua koki	√	√	√	√
230	*Chalcopsitta atra Scopoli, 1786*	Nuri hitam	√	√	√	√
231	*Chalcopsitta sintillata Temminck, 1835*	Nuri aru			√	√

No.	Order/Family/Species	Indonesian Name	Existing Species in Year:			
			2001	2002	2007	2011
232	*Charmosyna josefinae Finsch, 1873*	Perkici josephina			√	√
233	*Charmosyna placentis Temminck, 1834*	Perkici dagu-merah	√	√		√
234	*Charmosyna rubronotata Wallace, 1862*	Perkici kepala-merah	√		√	√
235	*Eclectus roratus Müller, 1776*	Nuri bayan	√	√	√	√
236	*Geoffroyus geoffroyi Bechstein, 1811*	Nuri pipi-merah	√	√	√	√
237	*Geoffroyus simplex Meyer, 1874*	Nuri kalung-biru	√	√		
238	*Loriculus aurantiifrons Schlegel, 1873*	Serindit papua			√	√
239	*Lorius lory Linnaeus, 1758*	Kasturi kepala-hitam	√	√	√	√
240	*Micropsitta keiensis Salvadori, 1875*	Nurikate topi-kuning				√
241	*Oreopsittacus arfaki Meyer, 1874*	Perkici arfak			√	
242	*Probosciger aterrimus Gmelin, 1788*	Kakatua raja	√	√	√	√
243	*Pseudeos fuscata Blyth, 1858*	Nuri kelam		√		√
244	*Psittaculirostris desmarestii Desmarest, 1826*	Nuriara besar				√
245	*Psittrichas fulgidus Lesson, 1830*	Kasturi raja		√		
246	*Tanygnathus megalorynchos Boddaert, 1783*	Betetkelapa paruh-besar			√	
247	*Trichoglossus haematodus Linnaeus, 1771*	Perkici pelangi	√	√	√	√
STRIGIFORMES						
Strigidae						
248	*Uroglaux dimorpha Salvadori, 1874*	Beluk papua	√		√	√
STRUTHIONIFORMES						
Casuariidae						
249	*Casuarius casuarius Linnaeus, 1758*	Kasuari gelambir-ganda	√		√	√
250	*Casuarius unappendiculatus Blyth, 1860*	Kasuari gelambir-tunggal	√			
Total Species			**120**	**122**	**108**	**142**

Source : Flora and Fauna Survey Result Report in the Tangguh LNG Project Site Year 2011

Based on the last survey in 2011, 142 bird species were found, with details of 63 species were found in lowland forest in Transect-1, 88 species in lowland forest in Transect-2, 86 species in lowland forest in Transect-3, 22 species in the mangrove ecosystem, 28 species in coastal forest, and 24 species in savanna and the Tangguh LNG Project Areas. The list of bird species found based on survey in 2011 presented in **Table II-85.**

Table II-83 List of Bird Species in the Tangguh LNG Areas Based on Survey in 2011

No.	Order/Family/Species	Indonesian Name	Survey in Year 2011					
			Tr1	Tr2	Tr3	HMR	HPT	SVN
	ANSERIFORMES							
	Anatidae							
1	*Tadorna radjah Lesson, 1828*	Umukia raja					√	
	APODIFORMES							
	Apodidae							
2	*Collocalia esculenta Linnaeus, 1758*	Walet sapi	√			√	√	√
3	*Mearnsia novaeguineae D'Albertis & Salvadori, 1879*	Kapinisjarum papua					√	
	Hemiprocnidae							
4	*Hemiprocne mystacea Lesson, 1827*	Tepekong jambul					√	
	CAPRIMULGIFORMES							
	Podargidae							
5	*Podargus ocellatus Quoy & Gaimard, 1830*	Paruhkodok pualam			√			
6	*Podargus papuensis Quoy & Gaimard, 1830*	Paruhkodok papua			√			
	CHARADRIIFORMES							
	Charadriidae							
7	*Charadrius leschenaultii Lesson, 1826*	Cerekpasir besar				√		
8	*Charadrius mongolus Pallas, 1776*	Cerekpasir mongolia				√		
9	*Pluvialis squatorola Linnaeus, 1758*	Cerek besar				√		
	Laridae							
10	*Chlidonias leucopterus Temminck, 1815*	Dara-laut sayap-putih					√	
11	*Sterna bergii Lichtenstein, 1823*	Dara-laut jambul					√	
12	*Sterna fuscata Linnaeus, 1766*	Dara-laut sayap-hitam					√	
13	*Sterna hirundo Linnaeus, 1758*	Dara-laut biasa					√	
	Scolopacidae							
14	*Actitis hypoleucos Linnaeus, 1758*	Trinil pantai				√		
15	*Calidris tenuirostris Horsfield, 1821*	Kedidi besar					√	
16	*Numenius phaeopus Linnaeus, 1758*	Gajahan penggala				√		
	CICONIIFORMES							
17	*Butorides striatus Linnaeus, 1758*	Kokokan laut				√		
18	*Egretta garzetta Linnaeus, 1766*	Kuntul kecil				√		
19	*Ixobrychus flavicollis Latham, 1790*	Bambangan hitam					√	
20	*Nycticorax caledonicus Gmelin, 1789*	Kowakmalam merah				√		
	COLUMBIFORMES							
	Columbidae							
21	*Chalcophaps indica Linnaeus, 1758*	Delimukan zamrud		√	√			
22	*Chalcophaps stephani Pucheran, 1853*	Delimukan timur	√	√	√			

No.	Order/Family/Species	Indonesian Name	Survey in Year 2011					
			Tr1	Tr2	Tr3	HMR	HPT	SVN
23	*Columba vitiensis Quoy & Gaimard, 1830*	Merpatihutan metalik		√				
24	*Ducula mullerii Temminck, 1835*	Pergam kalung		√				
25	*Ducula pinon Quoy & Gaimard, 1824*	Pergam pinon	√	√	√			
26	*Ducula rufigaster Quoy & Gaimard, 1830*	Pergam ekor-ungu		√				
27	*Ducula zoeae Lesson, 1826*	Pergam zoe		√	√			
28	*Macropygia amboinensis Linnaeus, 1766*	Uncal amban		√				
29	*Macropygia nigrirostris Salvadori, 1875*	Uncal paruh-hitam	√	√	√			
30	*Ptilinopus aurantiifrons Gray, 1858*	Walik dahi-jingga	√	√	√		√	
31	*Ptilinopus coronulatus Gray, 1858*	Walik lunggung		√				
32	*Ptilinopus iozonus Gray, 1858*	Walik perut-jingga	√	√	√			
33	*Ptilinopus magnificus Temminck, 1821*	Walik wompu		√				
CORACIIFORMES								
Alcedinidae								
34	*Alcedo azurea Latham, 1801*	Rajaudang biru-langit				√		
35	*Alcedo pusilla Temminck, 1836*	Rajaudang kecil				√		
36	*Ceyx lepidus Temminck, 1836*	Udangmerah kerdil	√	√	√			
37	*Clytoceyx rex Sharpe, 1880*	Rajaudang paruh-sekop	√	√	√		√	√
38	*Dacelo gaudichaud Quoy & Gaimard, 1824*	Kukabura perut-merah	√	√	√		√	√
39	*Dacelo leachii Vigors & Horsfield, 1826*	Kukabura sayap-biru			√			
40	*Melidora macrorrhina Lesson, 1827*	Rajaudang paruh-kait		√	√			
41	*Syma torotoro Lesson, 1827*	Cekakak torotoro	√	√	√			
42	*Tanysiptera galatea Gray, 1859*	Cekakakpita biasa	√	√	√			
43	*Tanysiptera nympha Gray, 1840*	Cekakakpita bidadari		√	√		√	
44	*Todiramphus chloris Boddaert, 1783*	Cekakak sungai				√		
45	*Todiramphus macleayii Jardine & Selby, 1830*	Cekakak rimba	√	√				
46	*Todiramphus nigrocyaneus Wallace, 1862*	Cekakak biru-hitam		√				
47	*Todiramphus sanctus Vigors & Horsfeld, 1827*	Cekakak australia		√		√	√	
48	*Rhyticeros plicatus Forster, 1781*	Julang papua	√	√	√			√
Coraciidae								
49	*Eurystomus orientalis Linnaeus, 1766*	Tionglampu biasa			√			
Meropidae								
50	*Merops ornatus Latham, 1801*	Kirikkirik australia			√			
CUCULIFORMES								
Cuculidae								
51	*Cacomantis variolosus Vigors & Horsfield, 1826*	Wiwik rimba	√	√	√			

No.	Order/Family/Species	Indonesian Name	Survey in Year 2011					
			Tr1	Tr2	Tr3	HMR	HPT	SVN
52	*Caliechthrus leucolophus Müller, 1840*	Kedasi topi-putih		√				
53	*Centropus bernsteini Schlegel, 1866*	Bubut hitam		√				
54	*Centropus menbeki Lesson & Garnot, 1828*	Bubut pini		√				
55	*Centropus phasianinus Latham, 1801*	Bubut ayam						√
56	*Eudynamys scolopaceus Linnaeus, 1758*	Tuwur asia	√	√	√			
57	*Microdynamis parva Salvadori, 1875*	Tuwur kerdil	√	√	√			
58	*Scythrops novaehollandiae Latham, 1790*	Karakalo australia	√	√	√			
	FALCONIFORMES							
	Accipitridae							
59	*Accipiter fasciatus Vigors & Horsfield, 1827*	Elangalap coklat					√	
60	*Accipiter novaehollandiae Gmelin, 1788*	Elangalap kelabu		√				√
61	*Accipiter poliocephalus Gray, 1858*	Elangalap pucat-sosonokan					√	
62	*Haliaeetus leucogaster Gmelin, 1788*	Elanglaut perut-putih				√	√	
63	*Haliastur indus Boddaert, 1783*	Elang bondol	√	√		√	√	√
64	*Pandion haliaetus Linnaeus, 1758*	Elang tiram					√	
	GALLIFORMES							
	Megapodiidae							
65	*Megapodius freycinet Gaimard, 1823*	Gosong kelam		√	√			√
66	*Talegalla fuscirostris Salvadori, 1877*	Maleo paruh-hitam	√	√	√			
	Phasianidae							
67	*Coturnix ypsilophora Bosc, 1792*	Puyuh coklat	√	√	√			
	GRUIFORMES							
	Rallidae							
68	*Eulabeornis castaneoventris Gould, 1844*	Mandar bakau				√		
69	*Gallirallus philippensis Linnaeus, 1766*	Mandarpadi kalung-kuning			√			√
70	*Porphyrio porphyrio Linnaeus, 1758*	Mandar besar						√
71	*Rallina tricolor Gray, 1858*	Tikusan tukar			√			
72	*Gerygone chloronota Gould, 1843*	Remetuk tunggir-hijau		√				
73	*Gerygone chrysogaster Gray, 1858*	Remetuk perut-emas		√	√			
74	*Gerygone levigaster Gould, 1843*	Remetuk bakau		√				
75	*Sericornis beccarii Salvadori, 1874*	Sericornis kecil	√	√				
76	*Sericornis rufescens Salvadori, 1876*	Sericornis vogelkop	√					
	Campephagidae							
77	*Coracina boyeri Gray, 1846*	Kepudangsungu kelek-coklat	√	√	√			
78	*Coracina melas Lesson, 1828*	Kepudangsungu hitam		√	√			
79	*Coracina tenuirostris Jardine,1831*	Kepudangsungu miniak				√		

No.	Order/Family/Species	Indonesian Name	Survey in Year 2011					
			Tr1	Tr2	Tr3	HMR	HPT	SVN
80	*Lalage atrovirens Gray, 1862*	Kapasan alis-hitam	√	√	√			
81	*Lalage leucomela Vigors & Horsfield, 1827*	Kapasan alis-putih		√	√			
82	*Lalage sueurii Vieillot, 1818*	Kapasan sayap-putih			√			
	Corvidae							
83	*Corvus orru Bonaparte, 1851*	Gagak orru	√	√		√	√	
	PASSERIFORMES							
	Cracticidae							
84	*Cracticus cassicus Boddaert, 1783*	Jagal papua			√			
	Dicaeidae							
85	*Dicaeum pectorale Müller, 1843*	Cabai papua	√	√	√			
	Dicruridae							
86	*Dicrurus hottentottus Linnaeus, 1766*	Srigunting jambul-rambut	√	√	√			
	Hirundinidae							
87	*Hirundo rustica Linnaeus, 1758*	Layang-layang asia					√	√
	Maluridae							
88	*Malurus alboscapulatus Meyer, 1874*	Cikrak-peri bahu-putih	√		√			√
89	*Malurus cyanocephalus Quoy & Gaimard, 1830*	Cikrak-peri kaisar	√	√	√			
	Meliphagidae							
90	*Conopophila albogularis Gould, 1843*	Isapmadu kalung-coklat	√	√	√			
91	*Lichenostomus versicolor Gould, 1843*	Isapmadu kepodang						√
92	*Melilestes megarhynchus Gray, 1858*	Isapmadu paruhpanjang			√			
93	*Meliphaga aruensis Sharpe, 1884*	Meliphaga aru			√			
94	*Meliphaga gracilis Gould, 1866*	Meliphaga anggun	√	√	√		√	
95	*Meliphaga montana Salvadori, 1880*	Meliphaga rimba	√	√	√			
96	*Myzomela obscura Gould, 1843*	Myzomela remang	√		√			
97	*Philemon buceroides Swainson, 1838*	Cikukua tanduk	√	√	√		√	√
98	*Timeliopsis griseigula Schlegel, 1871*	Cucuklurus coklat			√			
99	*Toxorhamphus novaeguineae Lesson, 1827*	Cucukpanjang perut-kuning	√	√	√			√
100	*Xanthotis flaviventer Lesson, 1828*	Isapmadu dada-coklat	√	√	√			
	Monarchidae							
101	*Monarcha chrysomela Garnot, 1827*	Kehicap emas		√				
102	*Monarcha guttulus Garnot, 1829*	Kehicap tutul	√	√	√			
103	*Monarcha manadensis Quoy & Gaimard, 1830*	Kehicap bertopi			√			
	Motacillidae							
104	*Motacilla flava Linnaeus, 1758*	Kicuit kerbau			√			

No.	Order/Family/Species	Indonesian Name	Survey in Year 2011					
			Tr1	Tr2	Tr3	HMR	HPT	SVN
	Nectariniidae							
105	*Cinnyris jugularis Linnaeus, 1766*	Burungmadu sriganti	√	√	√			
106	*Nectarinia aspasia Lesson & Garnot, 1828*	Burung-madu hitam	√	√	√	√		
	Oriolidae							
107	*Oriolus szalayi Madarász, 1900*	Kepudang coklat	√	√	√			
	Orthonychidae							
108	*Ptilorrhoa caerulescens Temminck, 1835*	Tepuspermata biru	√	√	√			
	Pachycephalidae							
109	*Pachycephala simplex Gould, 1843*	Kancilan kelabu		√	√			
110	*Pitohui ferrugineus Bonaparte, 1850*	Pitohui karat	√	√	√		√	√
111	*Pitohui kirhocephalus Lesson & Garnot, 1827*	Pitohui belang	√	√	√			
	Paradisaeidae							
112	*Paradisaea minor Shaw, 1809*	Cenderawasih kecil	√	√	√			
	Petroicidae							
113	*Microeca flavigaster Gould, 1843*	Sikatan perut-kuning	√	√	√			
114	*Microeca flavovirescens Gray, 1858*	Sikatan zaitun		√	√			
115	*Peneoenanthe pulverulenta Bonaparte, 1850*	Robin bakau				√		
	Pittidae							
116	*Pitta erythrogaster Temminck, 1823*	Paok mopo		√	√			
117	*Pitta sordida Müller, 1776*	Paok hijau			√			
	Ploceidae							
118	*Passer domesticus Linnaeus, 1758*	Burung-gereja rumah						√
	Pomatostomidae							
119	*Pomatostomus isidorei Lesson, 1827*	Cicapapua merah	√	√	√			
	Rhipiduridae							
120	*Rhipidura hyperythra Gray, 1858*	Kipasan perut-coklat	√	√	√			
121	*Rhipidura leucophrys Latham, 1801*	Kipasan kebun	√	√		√	√	√
122	*Rhipidura maculipectus Gray, 1858*	Kipasan-semak hitam	√	√	√			
123	*Rhipidura rufiventris Vieillot, 1818*	Kipasan dada-lurik	√	√	√			
124	*Rhipidura threnothorax Müller, 1843*	Kipasan-semak bayan			√			
	Sturnidae							
125	*Aplonis cantoroides Gray, 1862*	Perling kicau				√	√	√
	PSITTACIFORMES							
	Psittacidae							
126	*Cacatua galerita Latham, 1790*	Kakatua koki	√	√	√			√
127	*Chalcopsitta atra Scopoli, 1786*	Nuri hitam	√	√	√		√	
128	*Chalcopsitta sintillata Temminck, 1835*	Nuri aru	√	√				
129	*Charmosyna josefinae Finsch, 1873*	Perkici josephina	√	√	√			

No.	Order/Family/Species	Indonesian Name	Survey in Year 2011					
			Tr1	Tr2	Tr3	HMR	HPT	SVN
130	*Charmosyna placentis Temminck, 1834*	Perkici dagu-merah		√	√			
131	*Charmosyna rubronotata Wallace, 1862*	Perkici kepala-merah	√	√	√			
132	*Eclectus roratus Müller, 1776*	Nuri bayan	√	√	√			√
133	*Geoffroyus geoffroyi Bechstein, 1811*	Nuri pipi-merah	√	√	√			√
134	*Loriculus aurantiifrons Schlegel, 1873*	Serindit papua	√	√	√			
135	*Lorius lory Linnaeus, 1758*	Kasturi kepala-hitam	√	√	√			√
136	*Micropsitta keiensis Salvadori, 1875*	Nurikate topi-kuning	√	√	√			
137	*Probosciger aterrimus Gmelin, 1788*	Kakatua raja	√	√	√			
138	*Pseudeos fuscata Blyth, 1858*	Nuri kelam	√	√	√			
139	*Psittaculirostris desmarestii Desmarest, 1826*	Nuriara besar		√	√			
140	*Trichoglossus haematodus Linnaeus, 1771*	Perkici pelangi	√	√	√			√
STRIGIFORMES								
Strigidae								
141	*Uroglaux dimorpha Salvadori, 1874*	Beluk papua		√	√			
STRUTHIONIFORMES								
Casuariidae								
142	*Casuarius casuarius Linnaeus, 1758*	Kasuari gelambir-ganda			√			
Total Species			**63**	**88**	**86**	**22**	**28**	**24**

Source : Flora and Fauna Survey Result Report in Tangguh LNG Project Site Year 2011

Table II-84 Richness of Bird Species in the Tangguh LNG Area Based on Its Status

No	Scientific Name	Local Name	Location	Status		
				UU	CITES	IUCN
1	*Casuarius casuarius*	Kasuari gelambir muda	6	AB		VU ver 3.1
2	*Probosciger atterimus*	Kakatua Raja	4,5,6	AB	I	LC ver 3.1
3	*Lorius lory*	Kasturi Kepala-hitam	3,4,5,6	A	II	LC ver 3.1
4	*Accipiter fasciatus*	Elang Alap Coklat	8	AB	II	LC ver 3.1
5	*Accipiter novaehollandiae*	Elang Alap Kelabu	3.5	AB	II	LC ver 3.1
6	*Accipiter poliocephalus*	Elang Alap Pucat-sosonokan	8	AB	II	LC ver 3.1
7	*Haliaeetus leucogaster*	Elang Laut Perut-putih	7.8	AB	II	LC ver 3.1
8	*Haliastur indus*	Elang Bondol	2,3,4,5,7,8	AB	II	LC ver 3.1
9	*Pandion haliaetus*	Elang Tiram	8	AB	II	LC ver 3.1
10	*Cacatua galerita*	Kakatua Koki	2,3,4,5,6	AB	II	LC ver 3.1
11	*Eclectus roratus*	Nuri Bayan	3,4,5,6	AB	II	LC ver 3.1
12	*Rhyticeros plicatus*	Julang Papua	2,3,4,5,6	AB	II	TT
13	*Paradisaea minor*	Cenderawasih Kecil	4,5,6	ABC	II	LC ver 3.1
14	*Uroglaux dimorpha*	Beluk Papua	5.6		II	DD ver 3.1

No	Scientific Name	Local Name	Location	Status		
				UU	CITES	IUCN
15	*Chalcopsitta atra*	Nuri Hitam	4,5,6,8		II	LC ver 3.1
16	*Chalcopsitta scintilata*	Nuri Aru	4.5		II	LC ver 3.1
17	*Charmosyna josephinae*	Perkici Josephina	4,5,6		II	LC ver 3.1
18	*Charmosyna placentis*	Perkici Dagu-merah	5.6		II	LC ver 3.1
19	*Charmosyna rubronotata*	Perkici Kepala-merah	4,5,6		II	LC ver 3.1
20	*Geoffroyus geoffroyi*	Nuri Pipi-merah	6		II	LC ver 3.1
21	*Loriculus aurantiifrons*	Serindit Papua	4,5,6		II	LC ver 3.1
22	*Micropsitta keiensis*	Nurikate Topi-kuning	4,5,6		II	LC ver 3.1
23	*Pseudeos fuscata*	Nuri Kelam	4,5,6		II	LC ver 3.1
24	*Psittaculirostris desmarestii*	Nuriara Besar	5.6		II	LC ver 3.1
25	*Trichoglossus haematodus*	Perkici Pelangi	3,4,5,6	AB	II	LC ver 3.1
26	*Halcyon macleayii*	Cekakak Rimba	4.5	AB		DD ver 3.1
27	*Halcyon nigrocyanea*	Cekakak Biru-hitam	5	AB		DD ver 3.1
28	*Alcedo azurea*	Raja Udang Biru-langit	7	AB		LC ver 3.1
29	*Alcedo pusilla*	Raja Udang Kecil	7	AB		LC ver 3.1
30	*Ceyx lepidus*	Udang Merah Kerdil	4,5,6	AB		LC ver 3.1
31	*Clytoceyx rex*	Raja Udang Paruh-sekop	3,4,5,6,8	AB		LC ver 3.1
32	*Dacelo gaudichaud*	Kukabura Perut-merah	3,4,5,6,8	AB		LC ver 3.1
33	*Dacelo leachii*	Kukabura Sayap-biru	6	AB		LC ver 3.1
34	*Melidorra macrorrhina*	Raja Udang Paruh-kait	5.6	AB		LC ver 3.1
35	*Tanysiptera galatea*	Cekakak Pita Biasa	4,5,6	AB		LC ver 3.1
36	*Tanysiptera nympha*	Cekakak Pita Bidadari	5,6,8	AB		LC ver 3.1
37	*Egretta garzetta*	Kuntul Kecil	7	AB		LC ver 3.1
38	*Nycticorax caledonicus*	Kowak Malam Merah	7	AB		LC ver 3.1
39	*Chlidonias lecopterus*	Dara Laut Sayap-putih	8	AB		LC ver 3.1
40	*Sterna bergii*	Dara Laut Jambul	8	AB		LC ver 3.1
41	*Sterna fuscata*	Dara Laut Sayap-hitam	8	AB		LC ver 3.1
42	*Sterna hirundo*	Dara Laut Biasa	8	AB		LC ver 3.1
43	*Megapodius freycinet*	Gosong Kelam	3,5,6	AB		LC ver 3.1
44	*Talegalla fuscirostris*	Maleo Paruh-hitam	4,5,6	AB		LC ver 3.1
45	*Conopophila albogularis*	Isapmadu Kalung-coklat	4,5,6	AB		LC ver 3.1
46	*Melilestes megarchyncus*	Isap Madu Paruh Panjang	6	AB		LC ver 3.1
47	*Meliphaga aruensis*	Meliphaga Aru	6	AB		LC ver 3.1
48	*Meliphaga gracilis*	Meliphaga Anggun	4,5,6,8	AB		LC ver 3.1
49	*Meliphaga montana*	Meliphaga Rimba	4,5,6	AB		LC ver 3.1
50	*Myzomela obscura*	Myzomela Remang	4.6	AB		LC ver 3.1
51	*Philemon buceroides*	Cikukua Tanduk	3,4,5,6,8	AB		LC ver 3.1
52	*Timeliopsis griseigula*	Cucuk Lurus coklat	6	AB		LC ver 3.1
53	*Toxorhamphus novaeguineae*	Cucuk Panjang Perut-kuning	3,4,5,6	AB		LC ver 3.1
54	*Pitta erythrogaster*	Paok Mopo	5.6	AB		LC ver 3.1
55	*Numenius phaeopus*	Gajahan Penggala	7	AB		LC ver 3.1
56	*Halcyon chloris*	Cekakak Sungai	7	AB		TT

No	Scientific Name	Local Name	Location	Status		
				UU	CITES	IUCN
57	*Halcyon sancta*	Cekakak Australia	5,7,8	AB		TT
58	*Cinnyris jugularis*	Burung Madu Sriganti	4,5,6	AB		TT
59	*Leptocoma sericea*	Burung Madu Hitam	4,5,6,7	AB		TT
60	*Lichenostomus versicolor*	Isap Madu Kepodang	3	B		LC ver 3.1
61	*Xanthotis flaviventer [chrysotis]*	Isap Madu dada-coklat	4,5,6	B		LC ver 3.1
62	*Halcyon torotoro*	Cekakak Torotoro	4,5,6	B		TT

Source: Flora and Fauna Survey Result Report in the Tangguh LNG Project Site Year 2011

Remarks:

Distribution Location:
1. Babo
2. Bandara
3. Savanna & LNG Site
4. Transect 1
5. Transect 2
6. Transect 3
7. Transect 4
8. Transect 5

Conservation Status :
DD = Data Deficient
LC = Least Concern
VU = Vulnerable
TT = Not Registered
I = Appendix I
II = Appendix II
A = UU No. 5/1990 regarding the Conservation of Biological Natural Resources and its Ecosystem
B = PP No. 7/1999 regarding the Preservation of Flora and Fauna Species
C = PP No. 8/1999 regarding the Utilization of Flora and Wild Fauna Species

One of the protected bird species is the Papuan Hornbill. The existence of the Papuan Hornbill (*Rhyticeros plicatus*) bird found during the survey indicates that the forest in Tangguh LNG areas are in a good condition for the development of fruit–eating birds (*Frugivora*) and that there is still a mutuality relationship (mutually beneficial) which is relatively intact between the bird species of the tropical plant seed dispersers. The existence of the Papuan Hornbill can be used as bio-indicator of forest damage. In tropical forest, dispersal agents of fruit seed plants are generally conducted by fruit-eating fauna. The existence of this fauna is important to maintain the biodiversity and natural regeneration/rehabilitation of in tropical forest.

The flat topography and height difference with other low water surfaces causes the flooded swamp forest habitat species. Therefore, at the observation locations fish-eating bird (*piscivora*) species are also found such as the White-ballied Sea-eagle (*Haliaeetus leucogaster*), the Paradise-kingfisher (*Tanysiptera nympha*) bird, Mangrove Gerygone (*Gerygone levigaster*), Striated Heron (*Butorides striata*) and Common Paradise-kingfisher (*Tanysiptera galatea*).

The fruit-eating and seed-eating bird species and the nectar-sucking have important ecological roles i.e. for the dispersal of seeds and pollination. The Papuan Hornbill (*Rhyticeros plicatus*) bird and Double Wattle Cassowary (*Casuarius casuarius*) play roles in the dispersion of seeds through their manure. Apart from that, the Olive-backed Sunbird (*Cinnyris jugularis*) bird, the Purple-rumped Sunbird (*Leptocoma sericea*) bird and Varied Honeyeater (*Lichenostomus versicolor*) are examples of birds that suck honey and assist in the pollination of plants.

Herpetofauna

Based on observations and interviews with the community during survey activities in 2011, 31 species of herpetic-fauna were recorded in the Tangguh LNG areas consisting of 12 amphibian species and 19 reptile species. This survey found 50 specimens consisting of 10 amphibian individuals and 40 reptile individuals that are preserved as *voucher* specimens. Apart from that, the team also recorded two specimens of herpetic-fauna based on interviews with workers in the concession area, namely the presence of Saltwater Crocodile (*Crocodylus porosus*) and White-lipped Tree Frog (*Litoria infrafrenata*). Two reptile species namely Western Pacific Monitor Lizards (*Varanus indicus*) and Salvadori's Monitor (*Varanus salvadorii)* were found during the observations, however were not caught. A list of herpetofauna found in this survey can be observed in **Table II-87**.

Table II-85 Herpetofauna Species in the Tangguh LNG Area Based on Survey Results 2011 and its Conservation Status

Nr.	Name of Species	English Name	Collection Status	Conservation Status		
				PP No. 7/99	IUCN	CITES
AMPHIBIANSA						
Bufonidae						
1	*Duttaphrynus melanostictus*		NR	Np	ne	na
Dicroglossidae						
2	*Fejervarya limnocharis*		NR	Np	ne	Na
Hylidae						
3	*Litoria infrafrenata*	*Australian Giant Tree frog*	RIn	np	ne	na
4	*Litoria multicolor*	*Multi-colored Treefrog*	NR	np	ne	na
Microhylidae						
5	*Austrochaperina sp.*		NR	np	ne	na
6	*Cophixalus biroi*		NR	np	ne	na
7	*Hylophorbus sp.*	-	PNR	np	ne	na
Ranidae						
8	*Platymantis batantae*	*Wrinkled Ground Frog*	PNR	np	ne	na
9	*Platymantis papuensis*	*Papua Wrinkled Ground Frog*	R	np	ne	na
10	*Platymantis punctatus*	*Wrinkled Ground Frog*	NR	np	ne	na
11	*Rana papua*	*Papuan Wood Frog*	R	np	ne	na
12	*Rana daemeli*	-	NR	np	ne	na
REPTILIA						
Lizards						
Agamidae						
13	*Hypsilurus modestus*	*Modest Forest Dragon*	NR	np	ne	na
Gekkonidae						
14	*Cyrtodactylus marmoratus*	*Marbled Bow-fingered Gecko*	R	np	ne	na
15	*Cyrtodactylus papuensis*	*Papua Bow- fingered Gecko*	NR	np	ne	na
16	*Gehyra mutilata*	*tender-skinned house gecko*	NR	np	ne	na

Nr.	Name of Species	English Name	Collection Status	Conservation Status		
				PP No. 7/99	IUCN	CITES
		Scincidae				
17	*Carlia fusca*	*Indonesian Brown Skink*	R	np	ne	na
18	*Crytoblepharus novaeguineae*	*New Guinea Snake-eyed Skink*	PNR	np	ne	na
19	*Emoia caeruleocauda*	*Pacific Bluetail Emo Skink*	R	np	ne	na
20	*Emoia jakati*	*Kopstein's Emo Skink*	R	np	ne	na
21	*Emoia pallidiceps*	*Pale-headed Skink*	R	np	ne	na
22	*Emoia physicae*	*Slender Emo Skink*	R	np	ne	na
23	*Lygisaurus macfarlani*	*Translucent litter Skink*	R	np	ne	na
24	*Sphenomorphus florence*	-	NR	np	ne	na
25	*Sphenomorphus simus*	-	R	np	ne	na
		Varanidae				
26	*Varanus jobiensis*	*The peach throat monitor*	NR	P	ne	II
27	*Varanus salvadori*	*Crocodile Monitor*	R	np	ne	II
		Snakes				
		Colubridae				
28	*Boiga irregularis*	*Brown Cat Snake*	R	np	ne	na
		Elapidae				
29	*Micropechis ikaheka*	*New guinean Small-eyed Snake*	R	np	ne	na
		Turtles				
		Chelidae				
30	*Elseya novaguinea*	*New Guinea snapping turtle*	R	np	ne	na
		Crocodiles				
		Crocodylidae				
31	*Crocodylus porosus*	*Saltwater Crocodile*	RIn	P	ne	II

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

Remarks:
Based on the checklist of *de Rooij* (1915 & 1917), *Tyler* (1968); Brown (1991); *Cogger* (1994); *O'Shea* (1996); Iskandar & Ed Colijn (2000); *Menzies* (2006) and Uetz (2007).
NR=*New record*: New species Data/*Record* for Tangguh LNG, PNR=*Probably new record*: probably previously recorded in the survey of 2002 by another name (at least the same genus), however as there are no original species, it cannot be compared. R=*Recorded*: Previously recorded based on researches of Tangguh LNG (2002 and/or 2007). RIn=*recorded by interview*, *Unidentified*: not identified yet.
P=protected and np=not protected yet based on Government Regulations No. 7 year 1999, II=CITES *Appendix* II, na=not listed in CITES *Appendix*, ne=*not evaluated* based on IUCN

Based on the species found, nearly all are not protected by the Law of the Republic of Indonesia except the Saltwater Crocodile that is protected under the Government of Indonesia based on Government Regulation No. 7 year 1999 regarding the Preservation of Flora and Fauna. Although the Saltwater Crocodiles are included in CITES *Appendix* II, however, currently Indonesia agreed on a zero export quota of catches and exports can be conducted if the animal farms can meet the provided quota. Apart from that, there are six species of Monitor Lizards included in *Appendix*

II, one of which is the Salvadori's Monitor (*Varanus salvadori)* which export quota for 2007 are 200 each. There is no single species of herpetofauna in the Tangguh LNG area that is included in the IUCN Red List.

Almost all specimens are caught by hand. Glue traps produced only two individuals of one lizard species. The accumulative curve species provided to observe the relationship between search efforts and total number of species obtained produced a continued rising curve, in particular for amphibians **Figure II-144**. This indicates that the number of species in the Tangguh LNG are actually not all collected yet. With additional search time, it is expected that the number of species will increase. Information of the species obtained from interviews or caught by other team are not included in this graph.

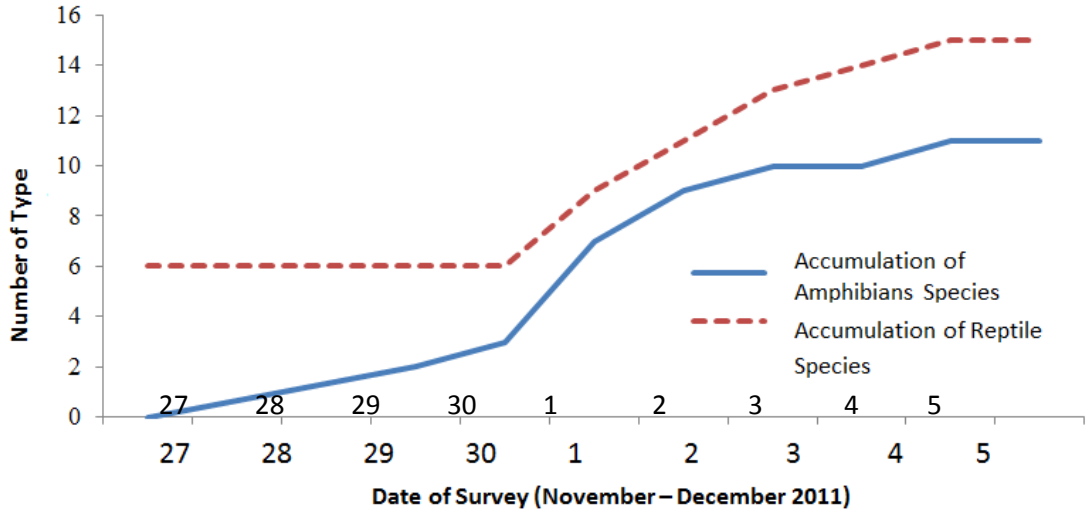


Figure II-144 **Species Accumulation Curve Based on Searches at the Tangguh LNG in 2011**

Distribution and Species Relative Abundance

When observed based on the habitat type, the total species of herpetofauna are mostly obtained in lowland forest compared to mangrove forest, swamp forest or areas surrounding the Stinkul Camp, namely the base area. Amphibians are only found in lowland forest and the Stinkul Camp. Species that are lasting in the surroundings of the Camp are two migrant frog species, i.e. *Duttaphrynus melanostictus* and *Fejervarya limnocharis* that are mostly found around water puddles below trailers where the workers live. Reptiles are found in three habitats, namely lowland forest, mangrove forest and swamp forest. Two snake species are only found in the lowland forest.

Because of time shortage, the chances are small to find out more information on the existing populations in depth, however from the observations a number of species of sizeable relative abundance can be seen. Species found consisting of only one or less than five species do not mean that the abundance is low. There is the possibility that the low-caught species in fact have high populations, however due to its cryptic (hidden) nature, it is difficult to detect and caught. In addition, the high frequency

of male voices heard indication of indicated that there is a high abundance of the species.

Table II-86 The Herpetofauna Species and Number of Individuals Found in Four Habitat/Location Types in the Tangguh LNG Areas Based on the Survey in 2011

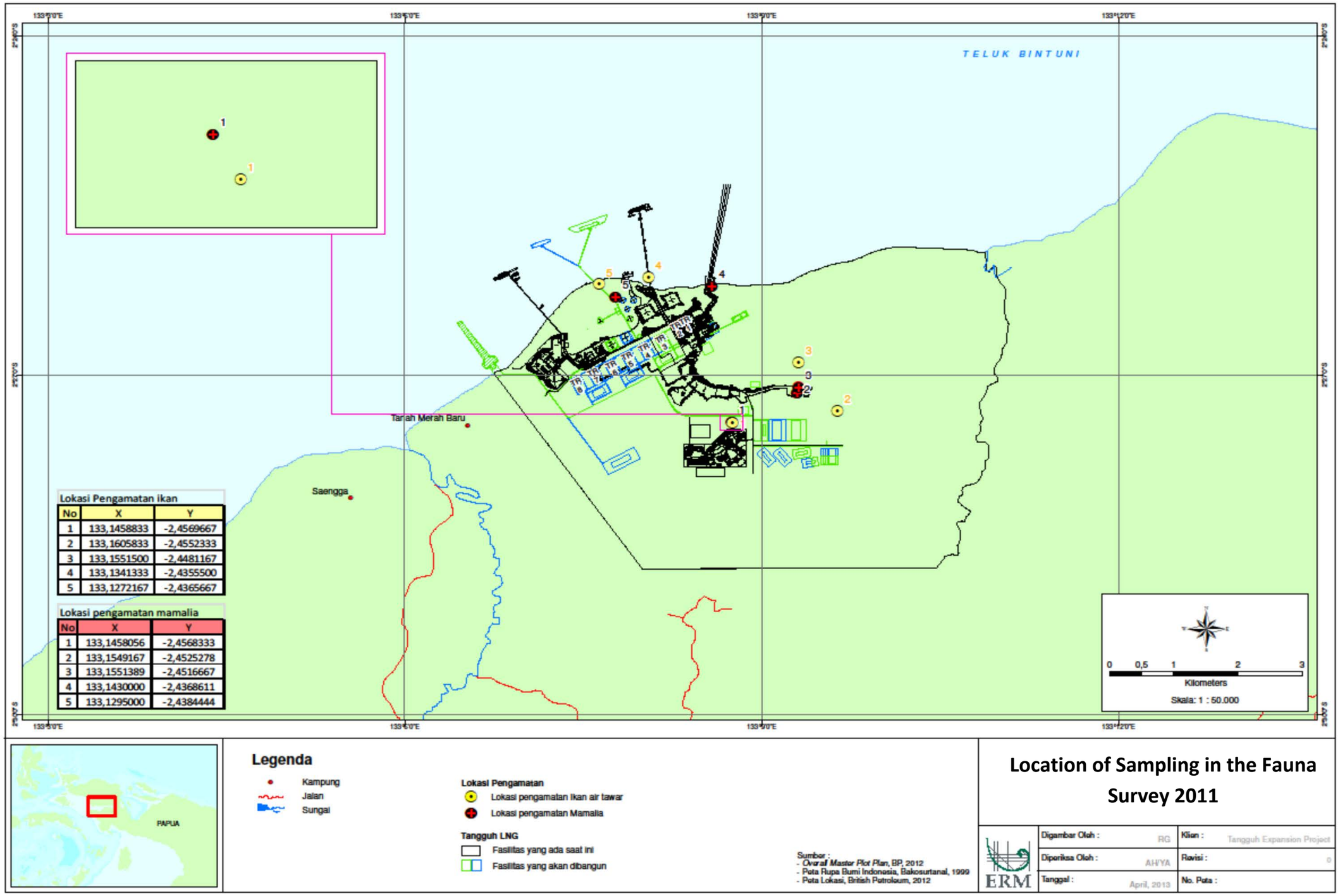
Taxa	Location of Observation			
	Lowland Forest	Mangrove Forest	Swamp Forest	Stinkul Camp
AMFIBIA				
Bufonidae				
Duttaphrynus melanostictus	0	0	0	2
Dicroglossidae				
Fejervarya limnocharis	1	0	0	1
Hylidae				
Litoria multicolor	2	0	0	0
Microhylidae				
Austrochaperina sp	2	0	0	0
Cophixalus biroi	1	0	0	0
Hylophorbus sp	1	0	0	0
Ranidae				
Platymantis batantae	3	0	0	0
Platymantis papuensis	7	0	0	0
Platymantis punctatus	4	0	0	0
Rana daemeli	5	0	0	0
Rana papua	12	0	0	0
REPTILIA				
Lizards				
Agamidae				
Hypsilurus modestus	1	0	0	0
Gekkonidae				
Cyrtodactylus marmoratus	5	0	0	0
Cyrtodactylus papuensis	1	0	0	0
Gehyra mutilata	1	0	0	0
Scincidae				
Carlia fusca	4	0	0	0
Cryptoblepharus novaguinea	0	1	0	0
Emoia caeruleocauda	4	0	0	0
Emoia jakati	2	0	0	0
Emoia palidiceps	15	0	0	0
Emoia physicae	4	0	0	0
Lygisaurus macfarlani	1	0	0	0
Sphenomorphus florense	2	0	0	0
Sphenomorphus simus	5	1	0	0
Varanidae				

Taxa	Location of Observation			
	Lowland Forest	Mangrove Forest	Swamp Forest	Stinkul Camp
Varanus jobiensis	0	0	2	0
Varanus salvadori	1	0	1	0
Snakes				
Colubridae				
Boiga iregularis	1	0	0	0
Elapidae				
Micropechis ikaheka	1	0	0	0
Total Species	**25**	**2**	**2**	**2**
Total Individuals	**86**	**2**	**3**	**3**

Source : Flora and Fauna Survey Result Report at Tangguh LNG Project Site Year 2011

Frog species which were most often found in around the Stinkul Camp and with relatively the high species abundance are *Duttaphrynus melanostictus* and *Fejervarya limnocharis*. While in the lowland forest, species mostly found were from the genus of *Ranidae* such as *P. papuensis* and *R. daemeli*. The voices of these species are often heard and the offspring's are found in the forest. Only few tree frogs were found. The *L. infrafrenata* tree frogs that were found in the survey of 2007 in a relatively high amount were not found at all, although a worker of Tangguh LNG reported tree frogs could be found in a tree near the employees' mess.

As for lizards, the most abundant species is the *C. marmoratus* that found in the surroundings of the lowland forest during night observations. The skink lizard is very diverse and is often difficult to catch. The total individuals of lizards found are relatively few, however this less describes the actual condition because lizards are fauna that evade very fast and are difficult to catch. Likewise for the snakes in which only one is caught for each species. The *E. novaguineae* turtles are estimated to be many in calm slow-flowing rivers in lowland forest, considering that netting in one day produces two offspring specimens. Turtles are included in species that are difficult to find due to its shy nature, successful capture of these species are mostly by the installation of snares in the habitats of the species.



Map II-17 Location of Sampling in the Fauna Survey 2011

Dragronflies, Beetles and Ladybugs

Observation activities of dragonflies, beetles and ladybugs in 2011 resulted in the discovery of 272 insect specimens. Most of them (243 specimens) were caught in the morning-afternoon time, while 29 specimens caught at night time. Based on the results of identification, the survey activities accomplished to record 20 species of dragonflies, 8 species of beetles and 10 species of ladybugs.

On dry land habitats, 11 species of dragonflies , six species of beetles, and seven species of ladybugs were found. On lowland and creeks habitats, ten species of dragonflies, two species of beetles, and two species of ladybugs were found. Whereas for the mangrove habitats, only four species of dragonflies were found and there were no beetles and ladybug species. In coastal swamps, seven dragonflies species, five species of beetles, and three species of ladybugs were found. The species of dragonflies, beetles and ladybugs caught in the flora fauna survey in the morning time are presented in **Table II-89**, while the night catching results are presented in **Table II-90**.

Table II-87 Species of Dragonflies, Beetles and Ladybugs in the Tangguh LNG Area Based Survey Results Dated November 16th – 23rd, 2011 Caught in the Morning

No.	Species	Habitat			
		Dry Soil	Lowlands & Creeks	Mangrove	Coastal Swamps
	Odonata (Dragonflies)				
1	*Agria emma*	0	2	0	17
2	*Anax junius*	0	1	0	0
3	*Brachydiplax chalybea*	0	0	0	1
4	*Brachythemis contaminata*	0	0	1	0
5	*Crocothemis servilia*	2	27	0	0
6	*Diplacodes trivialis*	0	0	0	7
7	*Ischura cervula*	1	8	0	2
8	*Libellulidae Spesies 4*	0	2	0	0
9	*Neurothemis decora*	0	1	5	0
10	*Neurothemis stigmatizans*	19	3	0	0
11	*Neurothemis terminata*	33	6	1	2
12	*Orthetrum sabina*	0	0	0	2
13	*Orthetrum testaceum*	1	0	0	0
14	*Pantala flavescent*	1	0	0	0
15	*Perithemis tenera*	0	5	0	0
16	*Rhyothemis resplendens*	2	0	0	0
17	*Rhyothemis sp.*	1	0	6	2
18	*Rhyothemis sp. (2)*	2	1	0	0
19	*Libellulidae Spesies 9*	2	0	0	0
20	*Zyxomma obtusum*	1	0	0	0

No.	Species	Habitat			
		Dry Soil	Lowlands & Creeks	Mangrove	Coastal Swamps
	Coleoptera (Beetles)				
1	*Ceratia flavomargiata*	5	0	0	3
2	*Chauliognathus pennsylvanicus*	1	0	0	1
3	*Chrysolina sp*	5	0	0	1
4	*Coccinela arquata*	2	0	0	0
5	*Corigetus isabellinus*	5	3	0	1
6	*Metriona cetenata*	0	0	0	10
7	*Scarabaedae1*	2	0	0	0
8	*Xylotrupes gideon*	0	8	0	0
	Hemiptera (Ladybugs)				
1	*Acanthocephala femorata*	2	1	0	0
2	*Anasa tristis*	10	0	0	0
3	*Coptosoma siamicum*	2	0	0	2
4	*Gelatocoris aculatus*	1	0	0	0
5	*Jalysus wichami*	0	0	0	2
6	*Lygidae mendax*	0	0	0	1
8	*Podisus maculiventris*	0	1	0	0
9	*Riptortus linearis*	3	0	0	0
10	*Triatoma sanguisuga*	2	0	0	0
Number of Species		**21**	**2**	**0**	**5**
Total Species		**106**	**69**	**13**	**54**

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

At night only six species were found consisting of four beetles species and two ladybugs species. This number is less compared to daytime surveys. Beetle and ladybug species found at night are presented in **Table II-90.**

Table II-88 Species of Insects (Dragonflies, Beetles and Ladybugs) at the Tangguh LNG Area Based on Survey Results Dated November 16th – 23rd, 2011 Caught at Night

No.	Species	Total Species in the Habitat Type	
		Dry Soil	Coastal Swamps
	Coleoptera (Beetles)		
1	*Chauliognathus pennsylvanicus*	16	0
2	*Ceratia flavomarginata*	2	1
3	*Chrysolina sp.*	3	1
4	*Xylotrupes gideon*	0	2
Total Species		**21**	**4**

No.	Species	Total Species in the Habitat Type	
		Dry Soil	Coastal Swamps
Hemiptera (Ladybugs)			
1	*Riptortus linearis*	0	1
2	*Coptosoma siamicum*	0	3
Number of Species		**0**	**4**
Total Species		**21**	**8**

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

All the species of dragonflies, beetles and ladybugs found during this survey, are not protected by the Law of the Republic of Indonesia and are not listed in the CITES Appendix. There are nine dragonflies species in the IUCN red list with the status of Least Concern. The List of dragonflies, beetles and ladybugs species found in the Tangguh LNG areas and its conservation status presented in **Table II-91**.

Table II-89 Species of Dragonflies, Beetles and Ladybugs in the Tangguh LNG Area Based on Survey Results in 2011 and its Conservation Status

No.	Species	Conservation Status		
		UU/PP No.7 Year 1999	IUCN Red List	CITES
***Odonata* (Dragonflies)**				
1	*Agria emma*	-	-	-
2	*Anax junius*	-	*Least Concern* (2009)	-
3	*Brachydiplax chalybea*	-	*Least Concern* (2010)	-
4	*Brachythemis contaminata*	-	*Least Concern* (2010)	-
5	*Crocothemis servilia*	-	*Least Concern* (2009)	-
6	*Diplacodes trivialis*	-	*Least Concern* (2010)	-
7	*Ischura cervula*	-	-	-
8	*Libellulidae Species 4*	-	-	-
9	*Neurothemis decora*	-	-	-
10	*Neurothemis stigmatizans*	-	-	-
11	*Neurothemis terminata*	-	*Least Concern* (2009)	-
12	*Orthetrum sabina*	-	*Least Concern* (2010)	-
13	*Orthetrum testaceum*	-	*Least Concern* (2011)	-
14	*Pantala flavescens*	-	*Least Concern* (2009)	-
15	*Perithemis tenera*	-	-	-
16	*Rhyothemis resplendens*	-	-	-
17	*Rhyothemis sp.*	-	-	-
18	*Rhyothemis sp. (2)*	-	-	-
19	*Libellulidae Species 9*	-	-	-
20	*Zyxomma obtusum*	-	-	-
Coleoptera (Beetles)				
1	*Ceratia flavomargiata*	-	-	-
2	*Chauliognathus pennsylvanicus*	-	-	-

No.	Species	Conservation Status		
		UU/PP No.7 Year 1999	IUCN Red List	CITES
3	*Chrysolina sp*	-	-	-
4	*Coccinela arquata*	-	-	-
5	*Corigetus isabellinus*	-	-	-
6	*Metriona cetenata*	-	-	-
7	*Scarabaedae1*	-	-	-
8	*Xylotrupes gideon*	-	-	-
***Hemiptera* (Ladybugs)**				
1	*Acanthocephala femorata*	-	-	-
2	*Anasa tristis*	-	-	-
3	*Coptosoma siamicum*	-	-	-
4	*Gelatocoris aculatus*	-	-	-
5	*Jalysus wichami*	-	-	-
6	*Lygidae mendax*	-	-	-
7	*Murgantia histrioniaa*	-	-	-
8	*Podisus maculiventris*	-	-	-
9	*Riptortus linearis*	-	-	-
10	*Triatoma sanguisuga*	-	-	-

Source : Flora and Fauna Survey Result Report at Tangguh LNG Project Site Year 2011

Based on data of **Table II-90** and **Table II-91**, it can be observed that the highest abundance of insects are in dry-land and lowland habitats, while there are not many insects in mangrove habitats. This is due to the vegetation in dry-land habitats are larger number and more diverse than other habitats. In addition, there are also possibilities of less time and repetition during the data sampling in the mangrove habitat and the use of data sampling technique with insect nets which is less effective in the insect data collection. It is recommended that insect data sampling use a combination of various techniques or collection methods. Several species of dragonflies, beetles and ladybugs are only found in particular habitats, while in other habitats the insects are not found.

In the dry-land and lowland habitats relatively more species in larger numbers are found. A number of insects are dominant species in a habitat. The dragonfly species *Neurothemis terminata* is dominant in dry-land habitats, while *Crocothemis servilia* dominates the lowland and creek habitats. The dragonfly species *Agria Emma* is mostly found in the coastal swamp habitat.

Anasa tritis ladybug species was found only in dry-land habitats and has a huge population number. Likewise is the beetle *Metriona cetenata* that was only found in the swampy coastal habitat with huge population number. The existence of particular insects species found in a habitat lead to a possibility that they are endemic insects in the habitat area and could be used as habitat indicator.

Soil Organism

Specimens collected in the study of soil organism were obtained by catching by hand with a support of pinset (hand sorting method). Therefore only certain animals could be caught, those who moves slowly and slow to react to the catching effort..

In addition, by hand sorting method, another issue is that the specimens are tend to be damaged on their body part (due to the strong pinset grip). This caused some difficulties in conducting identification on the specimen. Another issue in identification of these soil organism species are also caused by the size of soil organism that tends to be small (less than 1 cm). Data that were obtained then could indicated which organism groups that tend to occupy under the soil; on the soil litter; or on soil litter surface. Soil organism species found in the Buffer zone of the Tangguh LNG area include 18 ordo as presented in **Table II-92.**

Table II-90 Soil Organism Species Found in the Buffer Zone of the Tangguh LNG

No plot (soil or soil litter)	Soil Organism Species	Total of Individuals
1 soil litter	Larva *Coleoptera* (kumbang)	1
	Order *Dermaptera* (Family: *Forficulidae*)	2
	Order *Diplopoda*	2
	Order *Orthoptera* (Family: *Acrididae*)	1
	Order *Opiliones*	2
1 soil	Order *Diplopoda*	3
	Pheretima sp (cacing merah/cacing tanah)	4
2 soil litter	Order *Opiliones 2*	1
	Order *Araneae*	1
	Order *Opiliones 3*	1
	Order *Coleoptera* (Family: *Staphylinidae*)	1
	Order *Isoptera* (Family: *Termitidae*)	1
	Order *Hemiptera* (Family: *Coreidae*)	1
2 soil	Order *Dermaptera* (Family: *Forficulidae*)	2
	Order *Coleoptera* (Family: *Staphylinidae 2*)	1
	Pheretima sp (cacing merah/cacing tanah)	5
	Metaphire sp (Cacing hitam/cacing tanah)	1
	Larva Order *Coleoptera*	1
3 soil litter	Semut merah besar (Family: *Formicidae*)	2
	Arachnida, Order *Phalangida* (nama populer: *harvestman*)	1
	Semut merah kecil (Family: *Formicidae 1*)	1
	Order *Dermaptera* (Family: *Forficulidae*)	1
	Order *Opiliones*	2
4 soil litter	Rayap (Family: *Termitidae*)	1
	Class *Crustaceaea*, Order *Isopoda* (Family: *Oniscoidea*)	1
	Arachnida, Order *Phalangida* (nama populer: *harvestman*)	1
4 soil	*Pheretima sp* (cacing merah / cacing tanah)	3

No plot (soil or soil litter)	Soil Organism Species	Total of Individuals
	Order *Dermaptera* (Family: *Forficulidae*)	1
	Chilopoda (lipan), Order *Geophilomorpha*	2
5 soil litter	Semut, Family: *Formicidae*	4
	Order *Dermaptera* (Family: *Forficulidae*)	1
	Class *Crustaceaea*, Order *Isopoda* (Family: *Oniscoidea*)	1
	Arachnida,Order *Phalangida* (nama populer: *harvestman*)	1
	Orthoptera (jangkrik) (Family: *Gryllidae*)	
5 soil	Larva *Coleoptera* (kumbang) (Family: *Tenebrionidae*)	1
	Chilopoda (lipan), Order Geophilomorpha	1
	Order *Isoptera* (Family: *Termitidae*)	1
	Pheretima sp (cacing merah/cacing tanah)	5
	Order *Coleoptera* (kumbang) (Family: *Staphylinidae*)	2
	Order *Coleoptera* (kumbang) (Family: *Staphylinidae 2*)	1
6 soil litter	*Arachnidae*, Order *Scorpiones*	1
	Coleoptera (kumbang), Order *Tenebrionidae*	1
	Order *Opiliones*	1
	Order *Sphaerotherida* (Family: *Sphaeropocidae*)	2
	Semut hitam besar (Family: *Formicidae*, subFamily: *Ponerineae*)	1
	Kumbang, Order: *Coleoptera* (Family: *Scarabaeidae*)	1
6 soil	Order *Opiliones 5* (laba-laba)	3
	Pheretima sp (cacing merah/cacing tanah)	4
	Chilopoda (lipan), Order *Geophilomorpha*	1
	Order *Sphaerotherida* (Family: *Sphaeropocidae*)	1
7 soil litter	*Hemiptera* (Family: *Coreidae*)	1
	Class *Crustaceaea*, Order *Isopoda*; (Family: *Oniscoidea*)	4
	Order *Araneae* (golongan laba-laba)	1
	Order *Dermaptera* (Family: *Forficulidae*)	2
7 soil	*Uret* (larva kumbang) (Family: *Scarabaeidae*)	1
	Kumbang, Order *Coleoptera*	1
	Chilopoda (lipan), Order *Geophilomorpha*	1
	Pheretima sp (cacing merah/cacing tanah)	3
8 soil litter	*Arachnida*, Order *Phalangida* (nama populer: *harvestman*)	2
	Rayap , *Macrotermes sp*	1
	Semut merah biasa (Family: *Formicidae*, subFamily: *Dolichoderinae*)	2
	Orthoptera (Family: *Blattaria*)	1
	Semut hitam kecil	1
	Order *Dermaptera* (Family: *Forficulidae*)	1
8 soil	*Chilopoda*, Order: *Lithobiomorpha*	1
	Uret (larva kumbang) (Family: *Scarabaeidae*)	1
	Pheretima sp (cacing merah/cacing tanah)	3
	Diplopoda	1
	Laba-laba , Order *Opiliones*	1
	Semut merah biasa	1

No plot (soil or soil litter)	Soil Organism Species	Total of Individuals
	Larva *Diptera*	1

Source : Flora and Fauna Survey Result Report at the Tangguh LNG Project Site Year 2011

2.2.2 Aquatic Biology

The environmental baseline data collection of Aquatic biota within the study area boundaries was performed in three types of waters i.e. rivers, nearshore and offshore. Sampling of water biota in the dry season (July - August 2012) and wet season (March - April 2013) were conducted in the same location with the sampling location for water and sediment quality.

2.2.2.1 River Water Biota

The sampling of river water biota including phytoplankton, zooplankton and benthos were performed in Saengga River on the western boundary of the Tangguh LNG (SW 01) at coordinate of 02°27'59.8" S - 133°06'16.2" E and in Senindara River in the eastern of the Tangguh LNG site (SW 03) at coordinate of 02°31'54.8" S - 132°16'29.3" E (see **Map II-11** in Sub-Chapter of Water Quality).

Phytoplankton

Based on the results of identification, there are four classes, however only *Cyanophyceae* and *Bacillariophyceae* are dominant, while the percentage of *Chrysophyceae* and *Dinophyceae* are very small (**Figure II-145**). *Cyanophyceae* is represented by only one genus, namely the *Trichodesmium*. This genus is excessively found in seawaters and play an important role in the nitrogen fixation process for improving water fertilization. *Bacillariophyceae* is the producer that is required by many early phase of water organism as food sources.

Based on a recorded genera, most of them are similar to the genera found in the sea, although the sampling locations were conducted in river. This is likely affected by the sampling position within a distance that still allows the effects of sea tides. When high tide, seawater flows far into the river channels taking along all particles including phytoplankton that are motionless organisms.

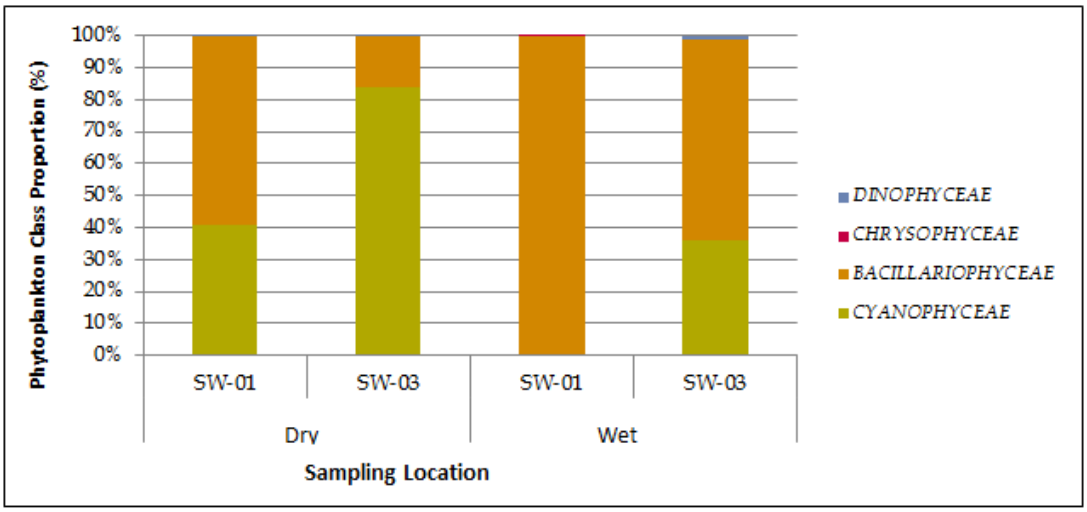


Figure II-145 Abundance Proportion of Phytoplankton Class (%) at Each River Water Observation Location in the Study Area Comparing the Dry Season and Wet Season Conditions

The high tidal conditions cause SW-01 located near the sea to have more balanced composition of the two classes in the dry season, however not in the wet season as all are dominated by *Bacillariophyceae*. This condition is unlike SW-03, in which the two classes are still found, even with a different percentage between the two seasons (**Figure II-145**). This is confirmed by water quality analysis result that indicates that the water quality in the SW-01 sampling location in the dry season as well as SW-03 in the dry season and the wet season have a water quality nature that is similar with seawater quality, whereas SW-01 location in the wet season indicates a freshwater quality. Accordingly, in this location almost 100% of phytoplankton is dominated by *Bacillariophyceae* class.

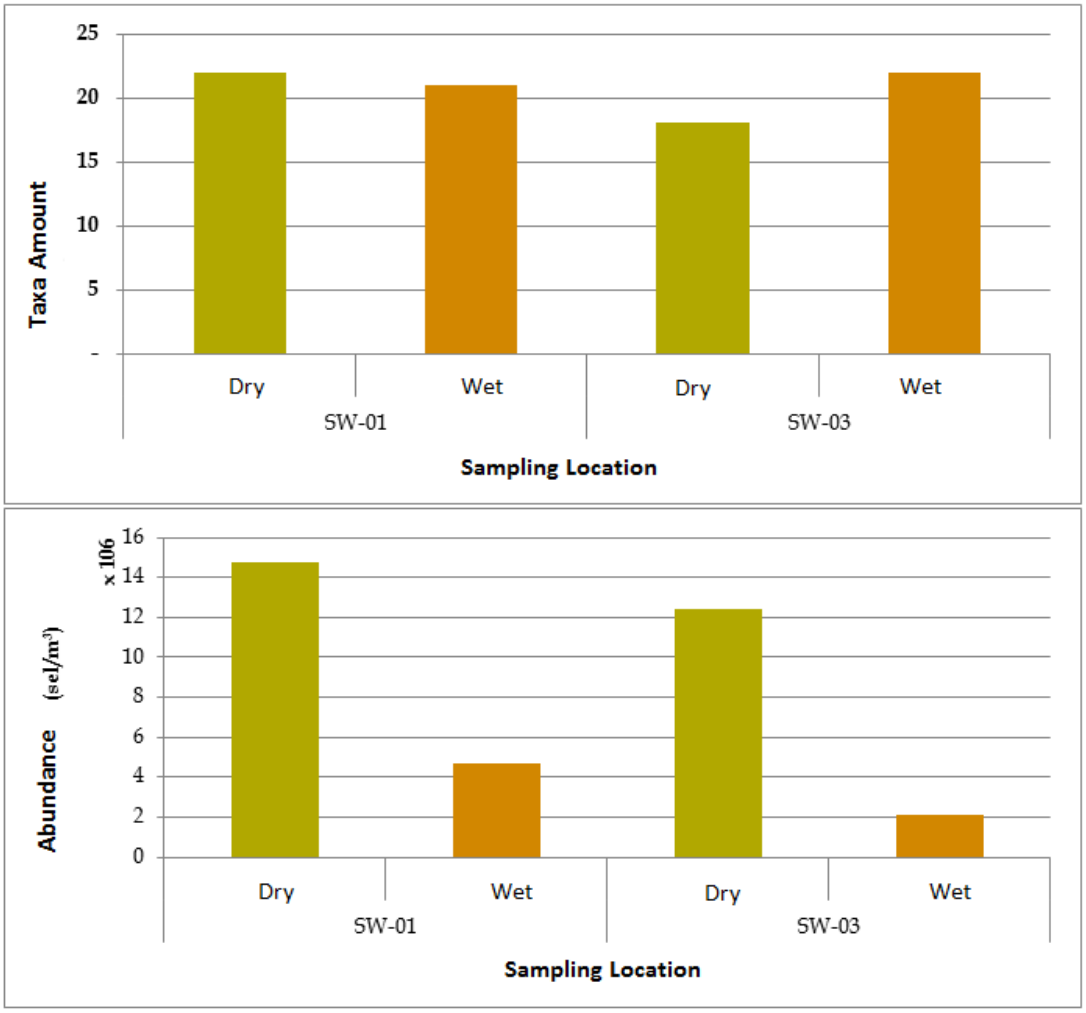
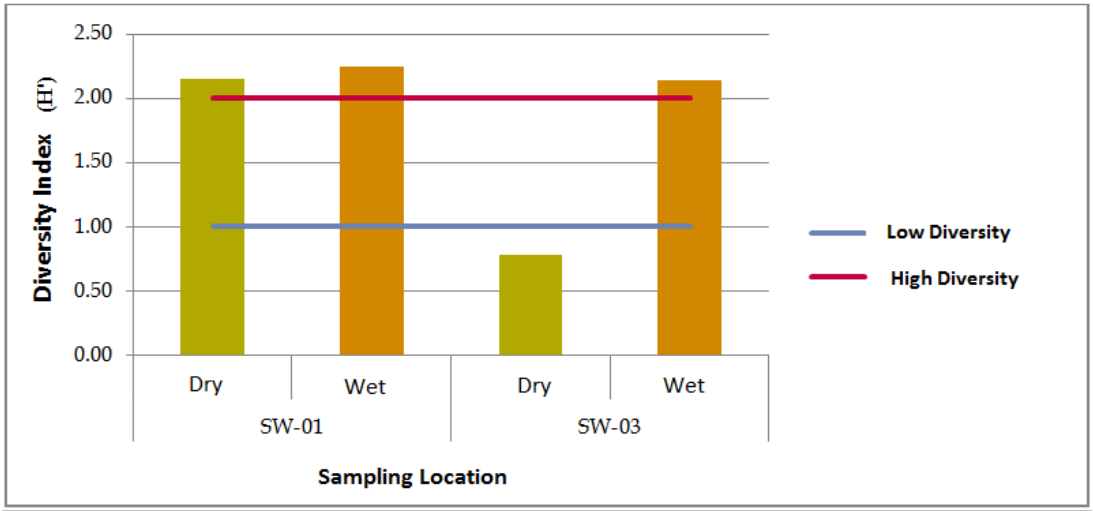


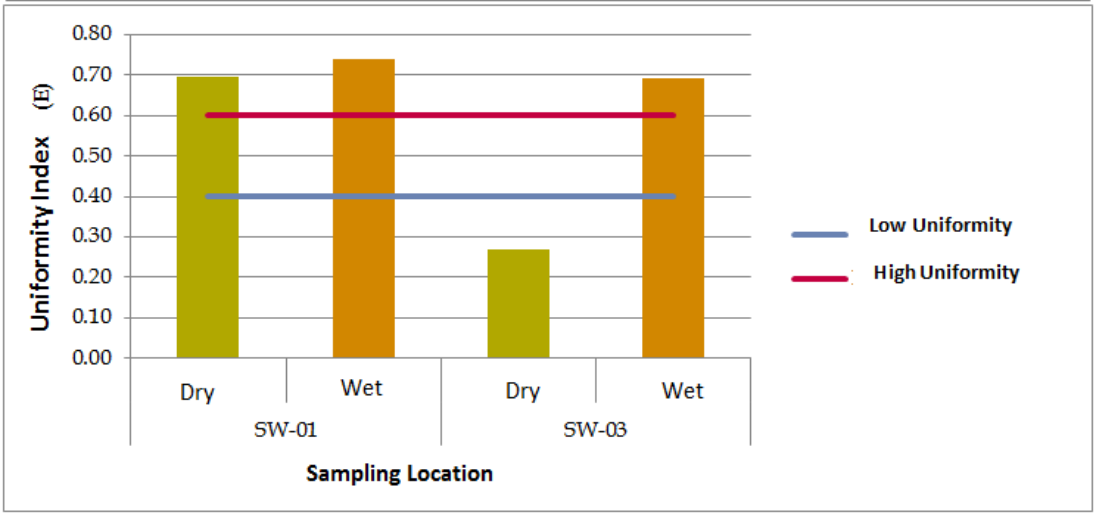
Figure II-146 **Taxa Amount and Abundance of Phytoplankton at Each Observation Location of River Water at Study Area Comparing the Dry Season and Wet Season Conditions**

Taxa amount of phytoplankton in river waters range between 18 – 22 (in dry seasons) and 21 – 22 taxa (in wet seasons). The difference in the taxa range number is not much between two seasons and is not directly proportional to abundance. Phytoplankton abundance in dry seasons are three to four times than the abundance in wet seasons. Contrast Abundance occurring from different sampling results is due to the extreme abundance of *Trichodesmium* (*Cyanophyceae*) genus. The phenomenon of the phytoplankton abundance was higher in dry season than in wet season is not exactly known the cause since in terms of the nutrients content and other water quality parameters to support phytoplankton growth, there were no noticeable differences were observed.

At the time of plankton sampling at SW-01 in the wet season, the tidal condition was at the lowest ebb. This condition can be observed from the TDS content at SW-01 of 70 mg/L which is freshwater. *Trichodesmium* is not a freshwater phytoplankton so it was not found at the time of the sampling.

The analysis results of phytoplankton community structure illustrated that there are no real differences between SW-01 and SW-03 in wet season. Similarly, with SW-01 in wet season and dry season. Season differences implicating the index value difference is found at SW-03 (**Figure II-147**). In wet season, either SW-01 as well as SW-03 have Diversity Index values (H') of more than 2, with a uniform distribution pattern (E>0.6) and moderate dominance (0.5<c<0.1). This condition also occurs at SW-01 during the dry season, however does not occur at SW-03 which diversity is very low (H' < 1) and with a very high dominance (c>0.5). This condition can be affected by extreme abundance of *Trichodesmium* as previously described.





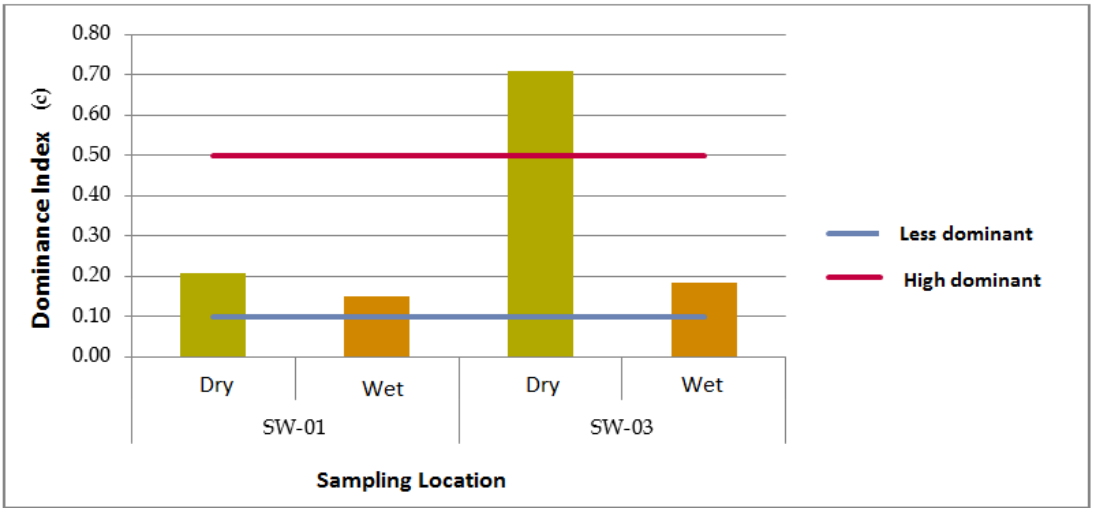


Figure II-147 **Diversity Index (H'), Uniformity (E) and Dominance (c) of Phytoplankton Community at Each River Water Observation Location in the Study Area Comparing the Dry Season and Wet Season Conditions**

Zooplankton

Zooplankton communities in two rivers with sampling location code of SW-01 and SW-03 can be observed in **Figure II-148**. During dry season, either at SW-01 or SW-03, only two classes of zooplankton are found, namely the *Crustacea* and *Protozoa*. *Crustacea* is more dominant than *Protozoa*. In wet season, in addition to above dominating two classes, other six classes are found, i.e. *Nematoda*, *Gastropoda*, *Pelecypoda* and *Urochirdata*.

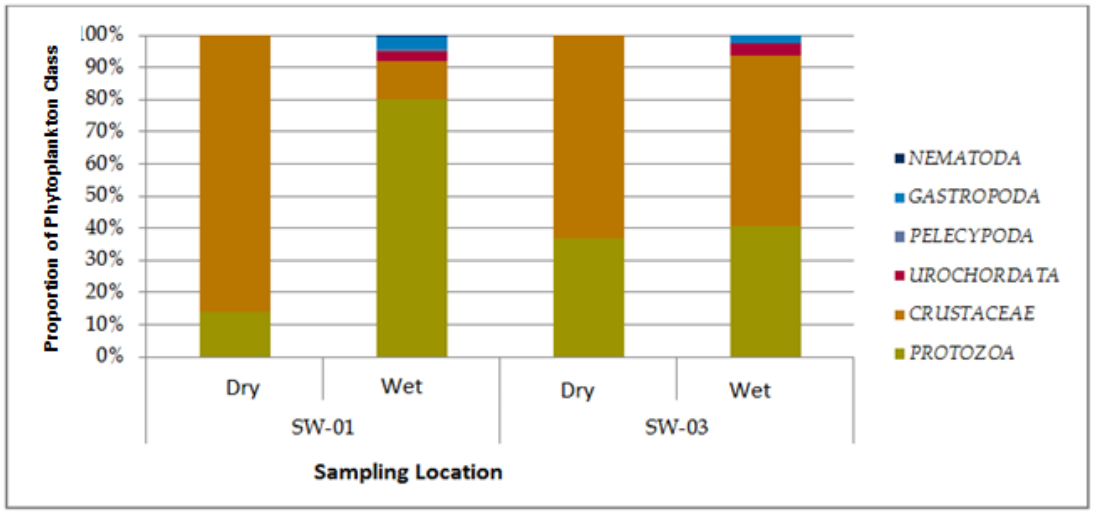


Figure II-148 Proportion of Zooplankton Class Abundance (%) at Each River Water Observation Location in the Study Area Comparing the Dry Season and Wet Season Conditions

The number of zooplankton taxa in rivers ranges between 5 – 7 in dry season, less than in wet season, which ranges from 10 – 13 taxa. Besides the number of taxa, zooplankton abundance also differs between dry season and wet season (**Figure II-149**). In wet season, the zooplankton abundance at SW-01 is almost four times higher than at SW-03. This difference originates from two *Protozoa* (*Leprotintinnus* and *Tintinnopsis*) genera and two taxa of *Crustacea* namely *Acartia* and *Nauplius*. *Crustacea*, particularly the stadia of *Nauplius* and *Copepod* genus *Acartia* are the first consumers level to be subsequent food source for fish offspring and other early stadia.

The zooplankton community structure at the study area shows Diversity Index (H') as moderate ($1 \leq H' < 2$), with a uniform distribution pattern ($E > 0.6$) and low dominance level ($c < 0.5$), except at SW-01 in dry season (**Figure II-150)**. The ecosystem stability is observed to be higher in wet season than in the dry season. The low diversity and high dominance at SW-01 in dry season is due to the dominant abundance of *Nauplius*.

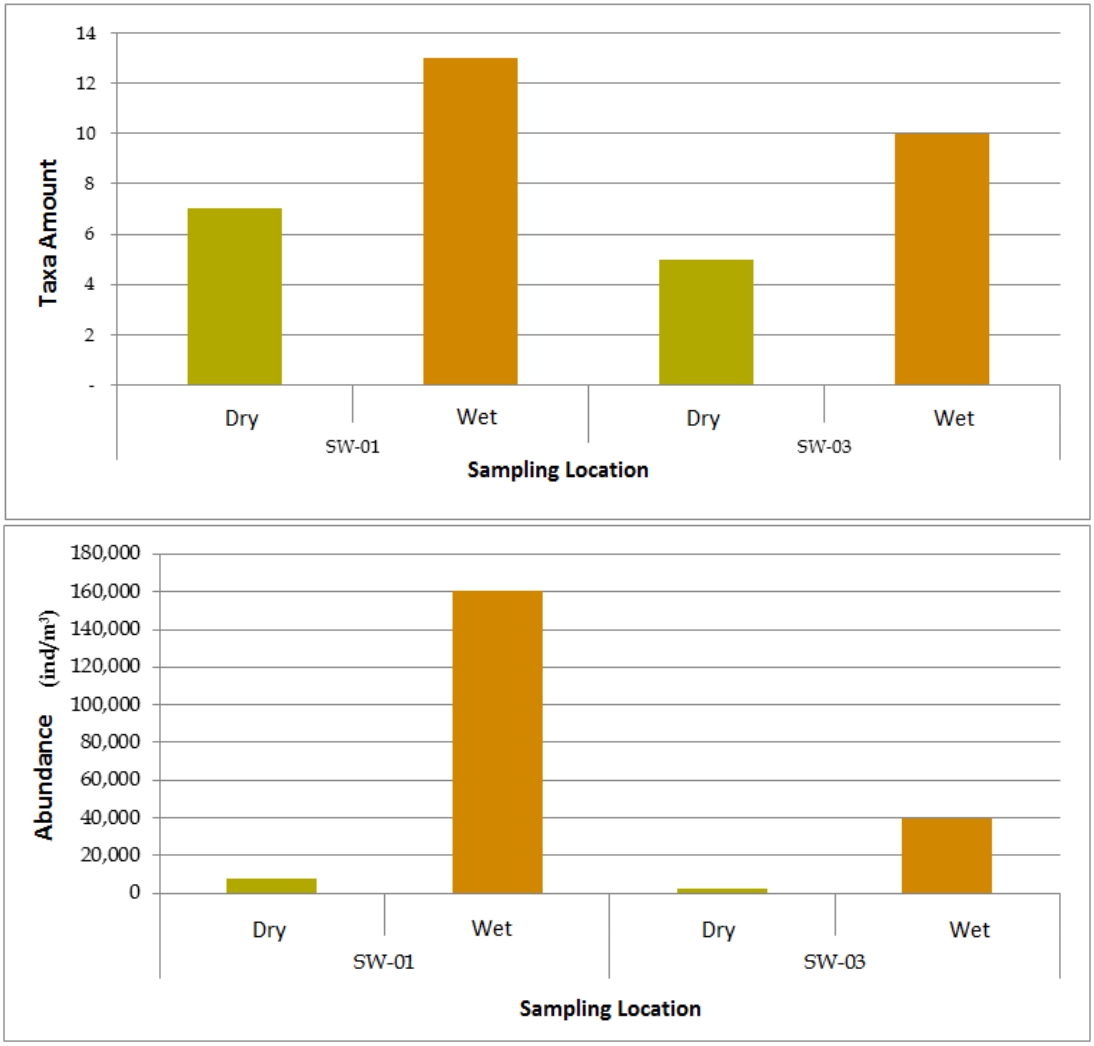


Figure II-149 **Number of Zooplankton taxa and Abundance at Each River Water Observation Location in the Study Area Comparing the Dry Season and Wet Season Conditions**

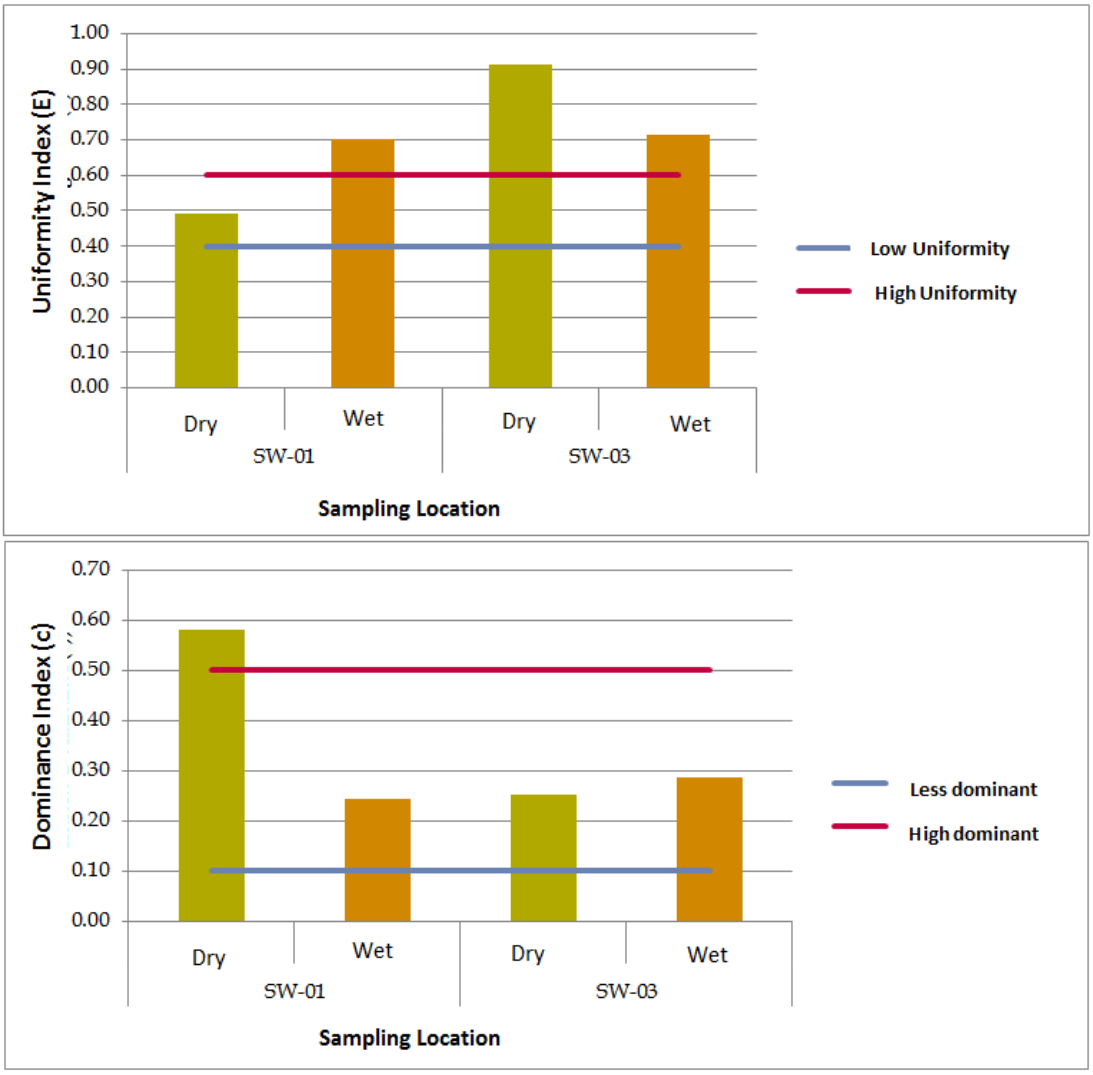


Figure II-150 **Diversity Index (H'), Uniformity (E) and Dominance (c) of Zooplankton Community at Each River Water Observation Location (SW = Surface Water) at the Study Area Comparing the Dry Season and Wet Season Conditions**

Benthos

There are only two dominant ommunity of benthos organism found namely *Crustacea* and *Polychaeta* (**Figure II-151**). *Crustacea* is organism that lives on the bed of waters, while *Polychaeta* organism lives in the base substrate, in particular the soft substrate and have high organic materials. Both are important components for the benthic waters environment.

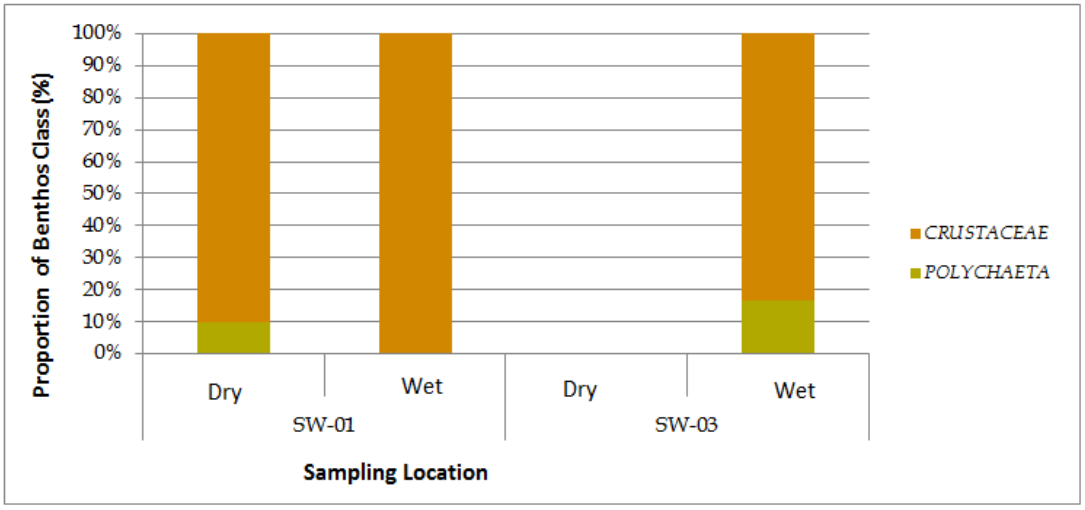


Figure II-151 **Abundance Proportion of the Benthos Organisms Class (%) at Each Observation Location at River Waters in the Study Area Comparing the Dry Season and Wet Season Conditions**

Based on the number of taxa and abundance, the benthos composition at SW-01 and SW-03 differ between the dry seasons and wet seasons (**Figure II-152**). During the dry season, benthos organisms were not found at the SW-03 point. In the wet season, the abundance at SW-01 and SW-03 are much lower compared to benthos abundance at SW-01 in dry season.

The difference in the number of taxa and abundance are presumably related to the substrate type and texture. As in common, a substrate that tends to be soft (in particular organisms in holes such as worms), with high organic matter and oxygen concentration is a decisive factor in the presence and distribution pattern of organisms. The substrate type and characteristic of the SW-01 differs from SW-03. At SW-01 the waters' bed is a muddy sand substrates, while at SW-03 it is a mixture of clay mud (silty-clay substrates) (**Figure II-153**). Substrates with clay textures are less suitable habitats for benthos, therefore the genus found in SW-03 are less.

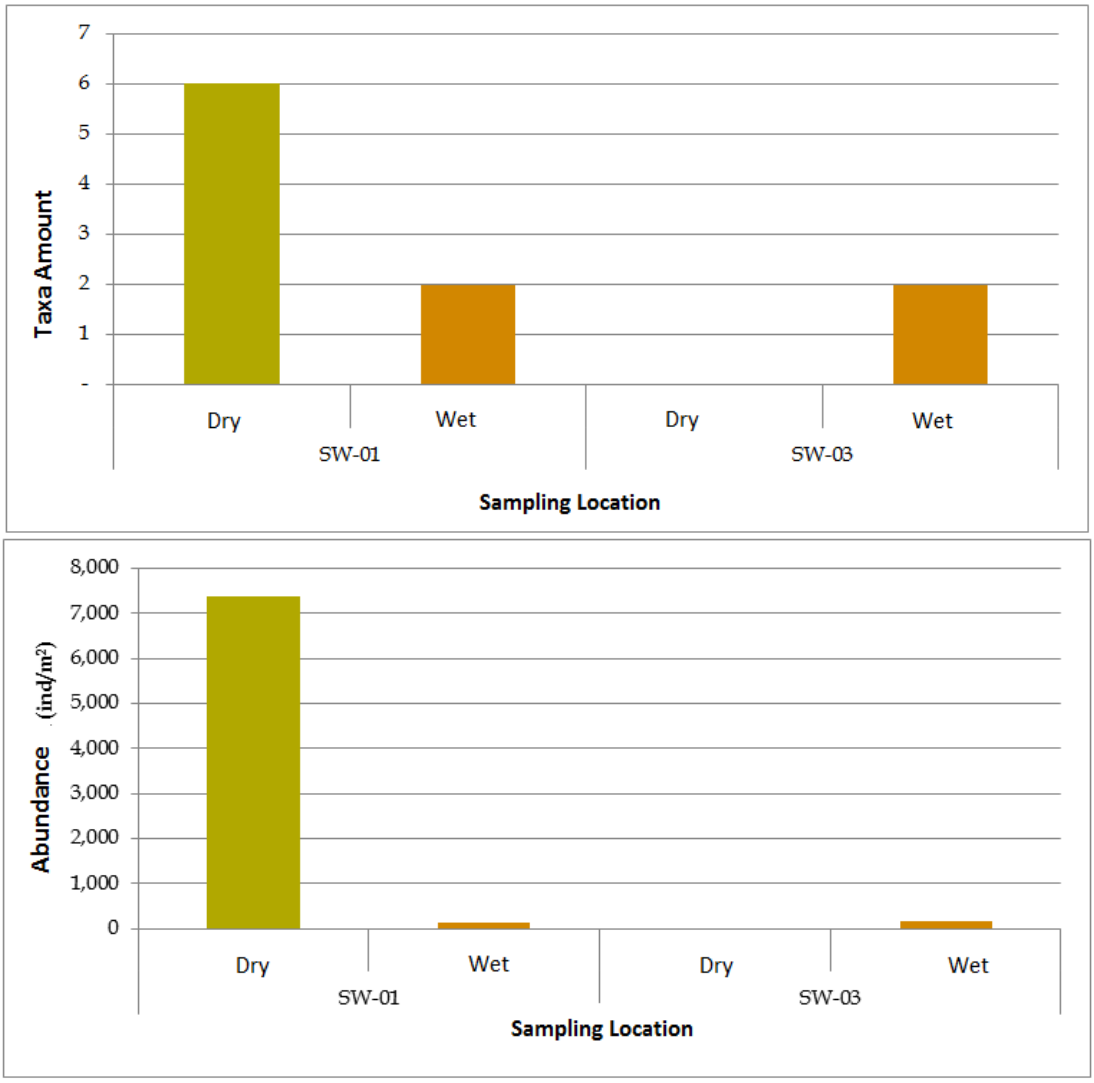


Figure II-152 **Number of Taxa and Benthos Abundance at Each River Water Observation Location at the Study Area Comparing the Dry Season and Wet Season Conditions**

Figure II-153 **Substrate Type of Muddy Sand (SW-01/left) and Clay Mud (SW-03/right) Cause Differences in the Number of Taxa and Benthos Abundance at the Study Area**

Based on abundance and number of taxa, the benthos community at the study area indicates low diversity (H' < 1) and a high dominance level (c> 0.5) (**Figure II-154**). This condition is presumably more affected by substrate physical condition and water mass movements at the bottom due to high tidal differences. The substrate condition was previously described, while the high tide condition are presumably less possible for a stable benthos colonization at the sampling location which position is relatively near the sea.

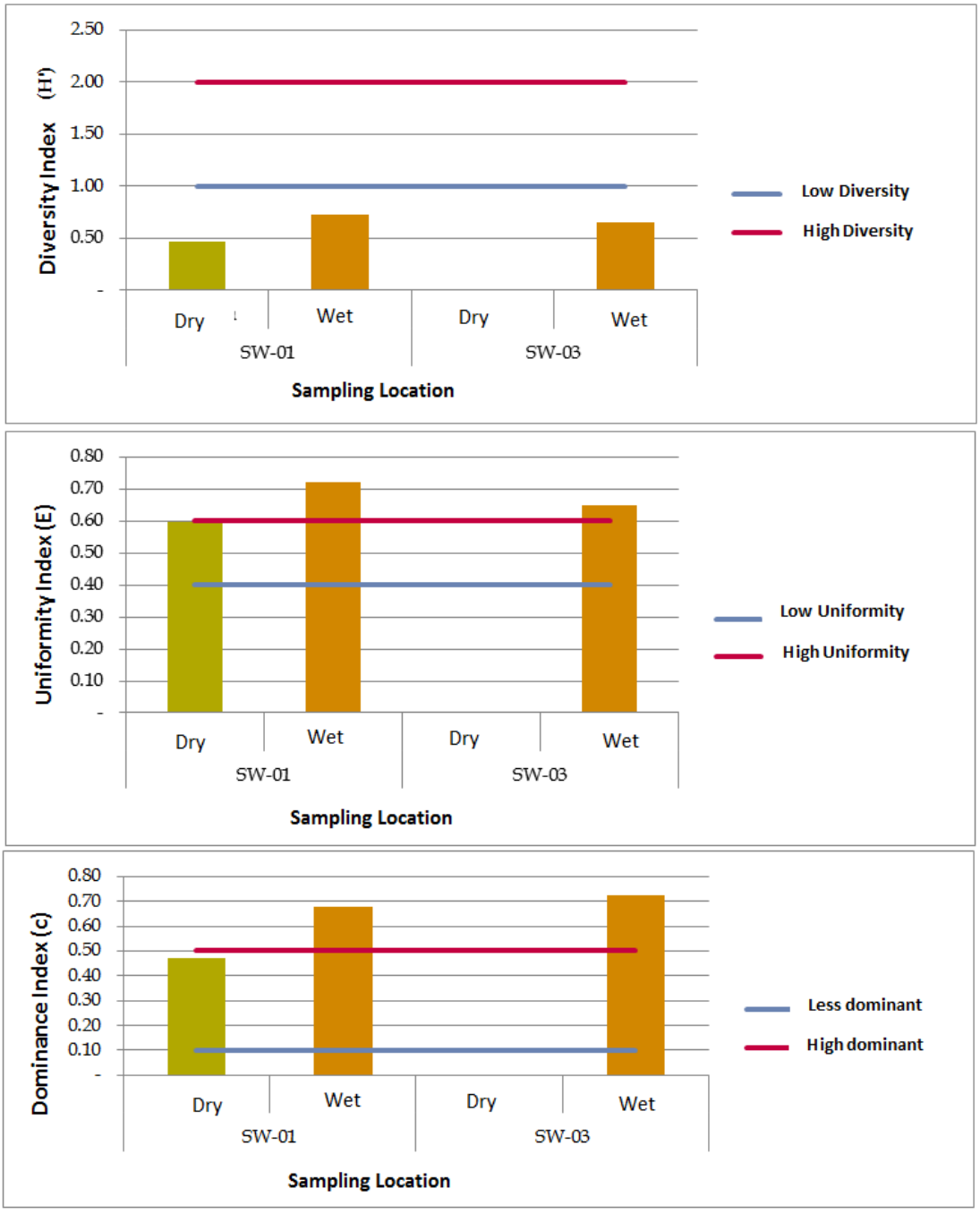


Figure II-154 **Diversity Index (H'), Uniformity (E), and Dominance (c) of Benthos Community at Each River Water Observation Location at the Study Area Comparing the Dry Season and Wet Season Conditions**

2.2.2.2 Seawater Biota

Sampling of sea water biota (consists of phytoplankton, zooplankton, and benthos) were conducted at nearshore and offshore during the dry season (July – August 2012) and wet season (March – April 2013). Sampling locations cover almost the entire Bintuni Bay area on the same sampling location with sampling location for Water and sediment quality (**Map II 13**). Tidal conditions during sampling of water biota can be observed at **Figure II-39** for the dry season and **Figure II-40** for wet seasons (at the Sub-chapter of Water Quality).

Phytoplankton

Based on phytoplankton identification result until genus level, phytoplankton can be grouped into four class namely *Cyanophyceae*, *Bacillariophyceae*, *Chrysophyceae* and *Dinophyceae*. The first two class are more dominant in abundance compared to last two classes either at nearshore or offshore locations. There are no real differences between nearshore (NS) and offshore (OS) locations (**Figure II-155**).

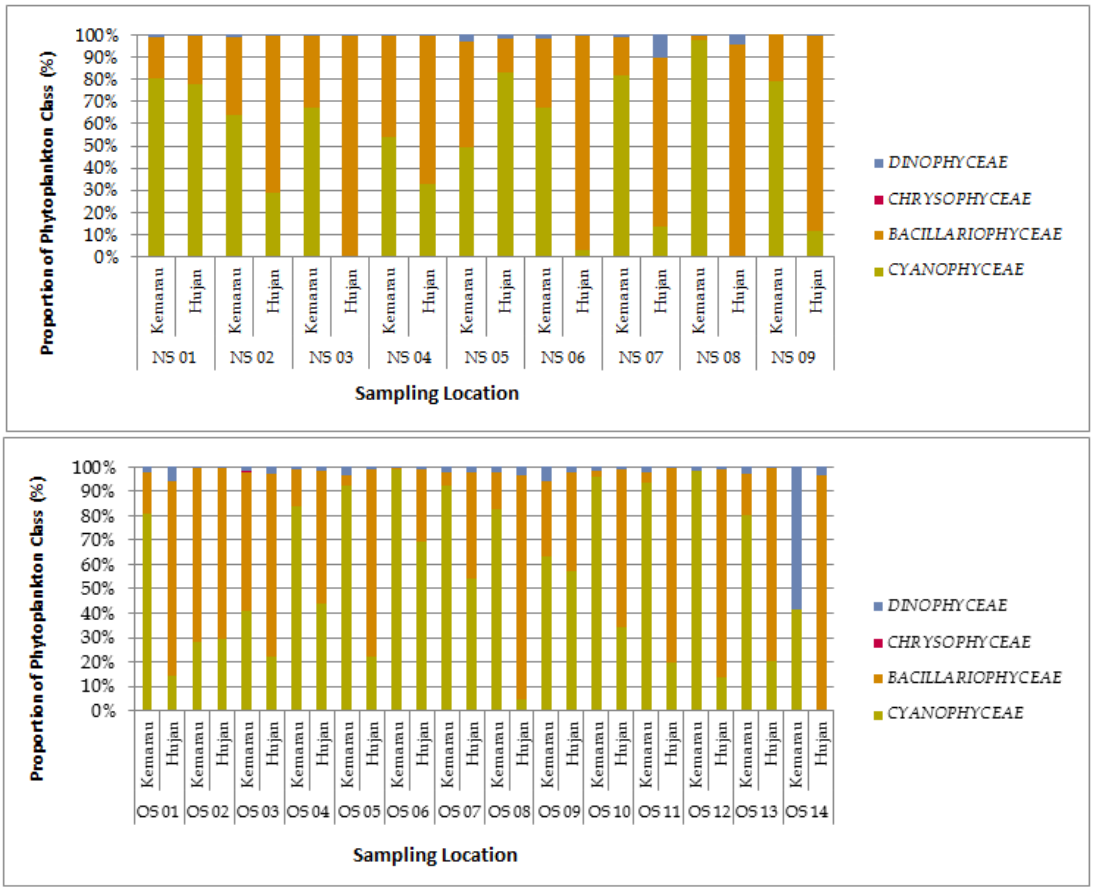


Figure II-155 Abundance Proportion of the Phytoplankton Class (%) at Each Seawater Observation Location (NS=nearshore; OS=offshore) at the Study Area Comparing the Dry Season and Wet Season Conditions

In dry season the abundance of *Cyanophyceae* was observed to be higher than other classes, except at the OS-02, OS-03, OS-10 and OS-14 points (offshore). The *Cyanophyceae* class is only represented by one genus, namely *Trichodesmium*. *Trichodesmium* is a member of filamentous *Cyanobacteria* class and is much found in the seawaters that are poor nutrient. Therefore, according to Rubin *et al*. (2011), its existence is very important in nitrogen fixation to increase the water productivity, nutrient flow, organic and inorganic matter cycles. In this case *Trichodesmium* provides pseudo basic substrates for many micro-organism in the sea including bacteria, diatom, dinoflagellata, protozoa and copepod.

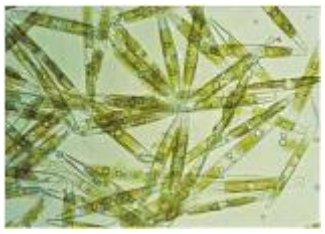
Figure II-156 *Trichodesmium* Genus, One of the *Cyanophyceae* Class members (Source: http://www.whoi.edu/sbl/liteSite)

In wet season, *Bacillariophyceae* is more dominant, except at NS-01, NS-05 (nearshore), OS-06, OS-07 and OS-09 (offshore). A number of dominant genus (found at all observation points) in the *Bacillariophyceae* class, are among others *Chaetoceros, Coscinodiscus, Nitzschia, Pleurosigma, Thalassionema dan Thalassiothrix* (**Figure II-157**). The genus is an important element for food chain in the sea, because it provides food for many early stadia including fishes and shrimps.

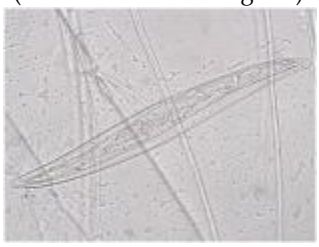
The shift between this two classes is presumably related to the difference of sea water quality. The relatively low salinity and sea water temperature at the sampling of plankton is presumably the increasing factor of *Bacillariophycea* during the wet season. *Trichodesmium* from *Cyanophyceae* class is much found in the sea with a salinity above 30 psu, while the salinity condition at the time of plankton sampling in the wet season ranges between 21.9 – 30.9 psu and the high temperature 29.5 -31.3 ˚C results in decrease of the *Trichodesmium* abundance, so that it is dominated by other classes such as *Bacillariophyceae* and *Dinophyceae*.

Chaetoceros
(www.vattenkikaren.gu.se)

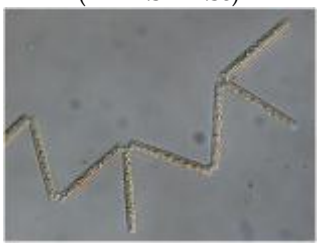
Coscinodiscus
(www.smhi.se)



Nitschia (www.antarctica.gov.au)



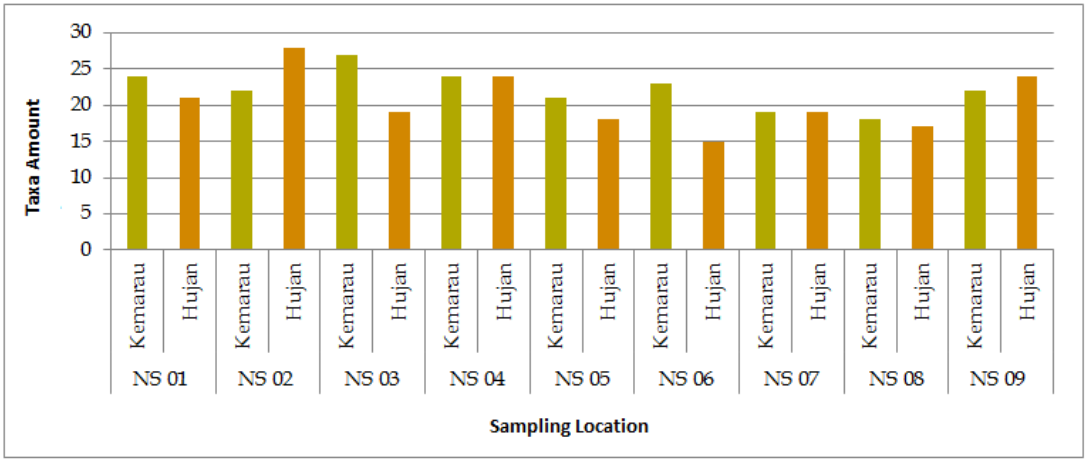
Pleurosigma
(www.commons.wikimedia.org)



Thalassionema
(oceandatacenter.ucsc.edu)

Thalassiothrix
(oceandatacenter.ucsc.edu)

Figure II-157 A Number of Dominant Genera, Members of the *Bacillariophyceae* Class



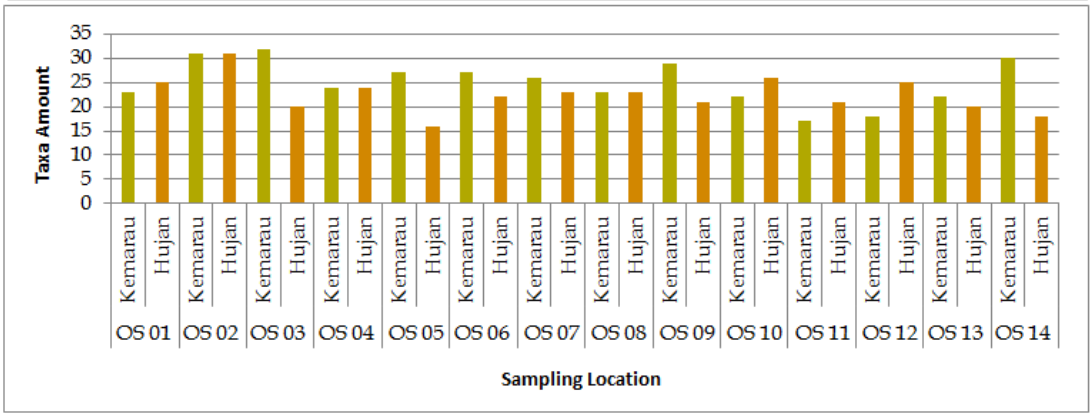


Figure II-158 Number of Phytoplankton Taxa at Each Seawater Observation Location (NS=nearshore, OS=offshore) at the Study Area Comparing the Dry Season and Wet Season Conditions

The number of phytoplankton taxa indicates a low fluctuation at all observation points (**Figure II-158**). A number of exceptions are NS-02, NS-03 and NS-06 (nearshore) and OS-03, OS-05, OS-09, OS-12 and OS-14 (offshore). In dry season, the number of taxa ranges between 18 to 27 (nearshore) and 17 to 31 (offshore), while in wet season the number of taxa ranges between 15 to 28 (nearshore) and 16 to 31 (offshore). It can be observed that in wet season the range of phytoplankton genus number at nearshore tend to be more than offshore.

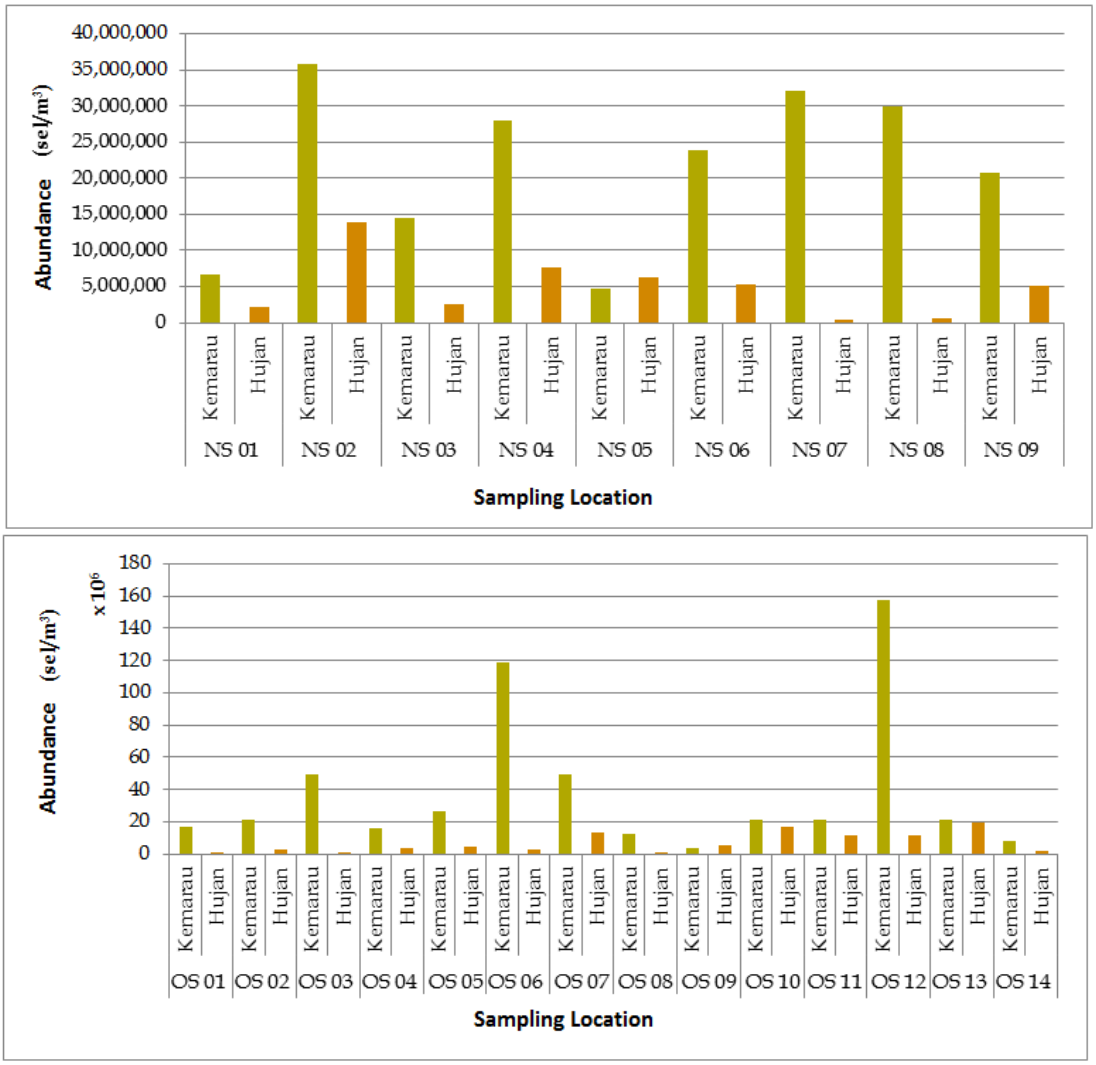


Figure II-159 Phytoplankton Abundance at Each Seawater Observation Location (NS=nearshore, OS=offshore) in the Study Area Comparing the Dry Season and Wet Season Conditions

In all observation locations, phytoplankton abundance in dry season are higher than in wet season (**Figure II-159**). Phytoplankton abundance is not directly proportional to the number of taxa. This is presumably due to the presence of very extreme *Trichodesmium* in dry season, in particular at OS-12. The abundance range in the dry season are 1 x 10^7 to almost 16 x 10^7 cell/m^3, while in wet season almost all are <2 x 10^7 sel/m^3. The component of the taxa number and above abundance will affect the analysis results against the biotic indexes.

The Diversity (H'), Uniformity (E) and Dominance (c) index are the functions of the taxa number and abundance. In normal conditions, the H' index is directly proportional to the E index, but reversely proportional to the c Index. In dry season conditions, the abundance of *Trichodesmium* genus is very high and indicates a taxa dominance compared to others. These conditions indicate that the distribution pattern is not uniform, but more patchy which means irregular. Therefore, in dry seasons the range of the H' value is almost entirely included in 'Low' and 'Moderate (H'< 2) category, except OS-14. The 'Moderate' Diversity Index indicates that the productivity is sufficiently high, with a balanced ecosystem condition and moderate ecological pressures. Meanwhile, the 'Low' Diversity Index indicates that the location is poor, a low productivity, heavy ecological pressure and instable ecosystem. However, in a number of locations in wet seasons such as at NS-02, NS-03, NS-04, NS-07, NS-08, OS-01 and OS-13 indicate a 'High' Diversity Index.

Figure II-160 Diversity Index (H') of Phytoplankton Community at Each Seawater Observation Location (NS = nearshore; OS = offshore) at the Study Area Comparing the Dry Season and Wet Season Conditions

A number of locations that have a 'High" Diversity Index (H' > 2.5) as mentioned above, also indicate that the Uniformity Index is also 'High' (E > 0.60). The 'High" Uniformity Index is also indicated at a number of other locations, such as OS-04, OS-07 and OS-14 during dry seasons, OS-05, OS-08 and OS-11 during wet seasons and OS-03 and OS-06 during dry and wet seasons. The 'high' Uniformity Index means that every species have a relatively same amount. If the Uniformity Index is higher, then more same amount of the every species. If the Uniformity Index is lower, then a number of species have a higher amount compared to other species.

Figure II-161 Uniformity Index (E) of the Phytoplankton Community at Every Seawater Observation Location (NS = Nearshore; OS = Offshore) in the Study Area Comparing the Dry Season and Wet Season Conditions

In the dry season, most of the sampling locations (14 stations) have a 'High' Dominance Index, while in the wet season, only NS-01 and NS-05 have a 'High' Dominance Index. This condition causes that the phytoplankton distribution pattern in the dry season is not uniform (**Figure II-162**).

Interpretation of the three indexes is frequently used to observe the ecosystem stability level. The ecosystem tends to be stable if the community is characterized by H' > 2.0; E ≥ 0.6 and c < 0.5. Therefore, in general based on phytoplankton community, the water condition in wet seasons tends to be more stable compared to dry seasons.

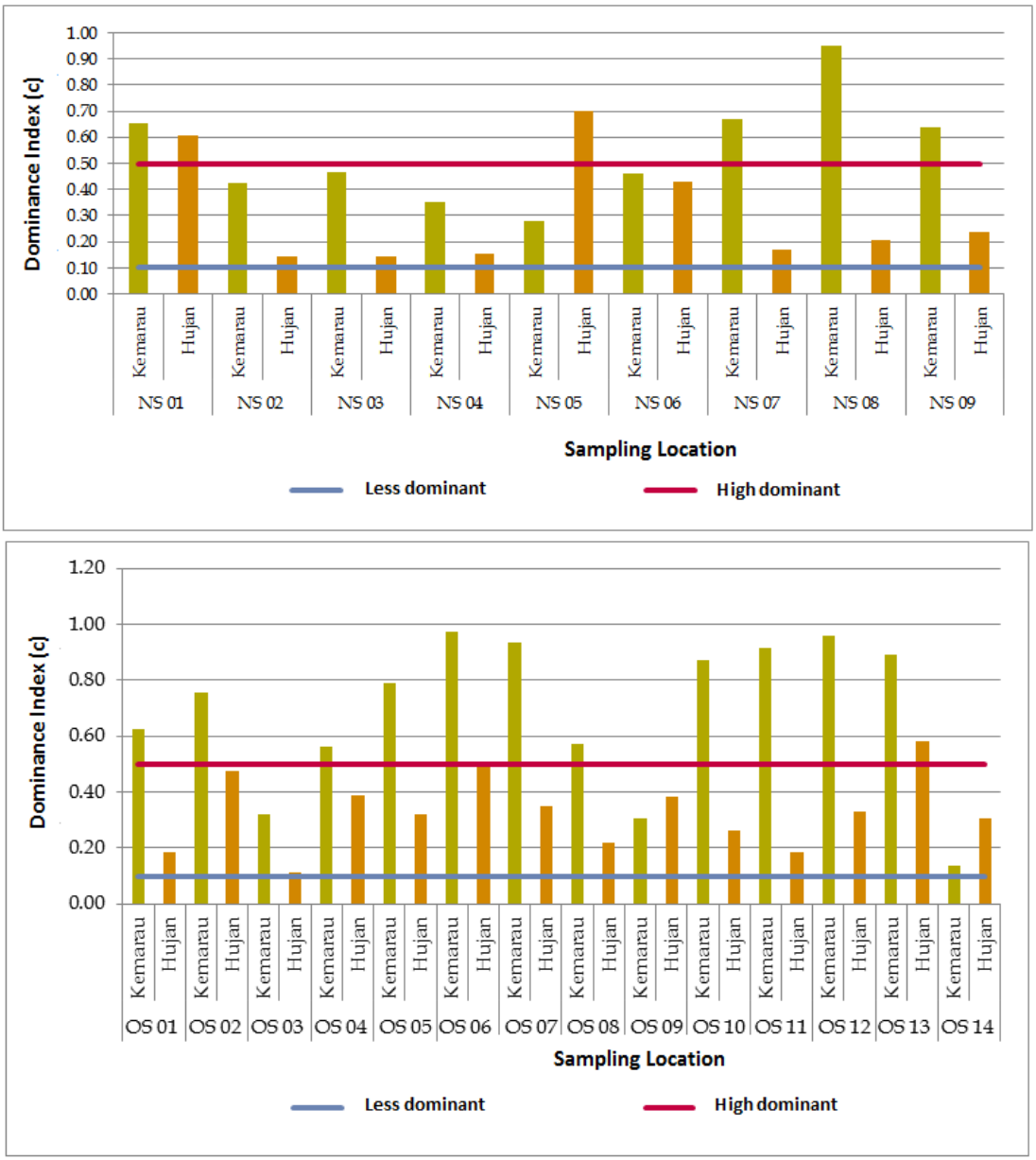


Figure II-162 **Dominance Index (c) of Phytoplankton Community at Each Seawater Observation Location (NS = Nearshore; OS = Offshore) in the Study Area Comparing the Dry Season and Wet Season Conditions**

Zooplankton

The zooplankton community composition based on identification results are grouped into eight classes, namely *Protozoa, Crustacea, Urochordata, Chaetognatha, Nemertina, Polychaeta, Pelecypoda and Gastropoda*. Overall only *Crustacea* and *Protozoa* are dominant in which *Crustacea* has a percentage of 30-90% and *Protozoa* 5-55%. There are no specific tendencies between the composition and location, but observation results indicate that there are no significant differences between the dry seasons and wet seasons. The proportion of the six classes of other zooplankton fluctuate relatively narrow (**Figure II-163**).

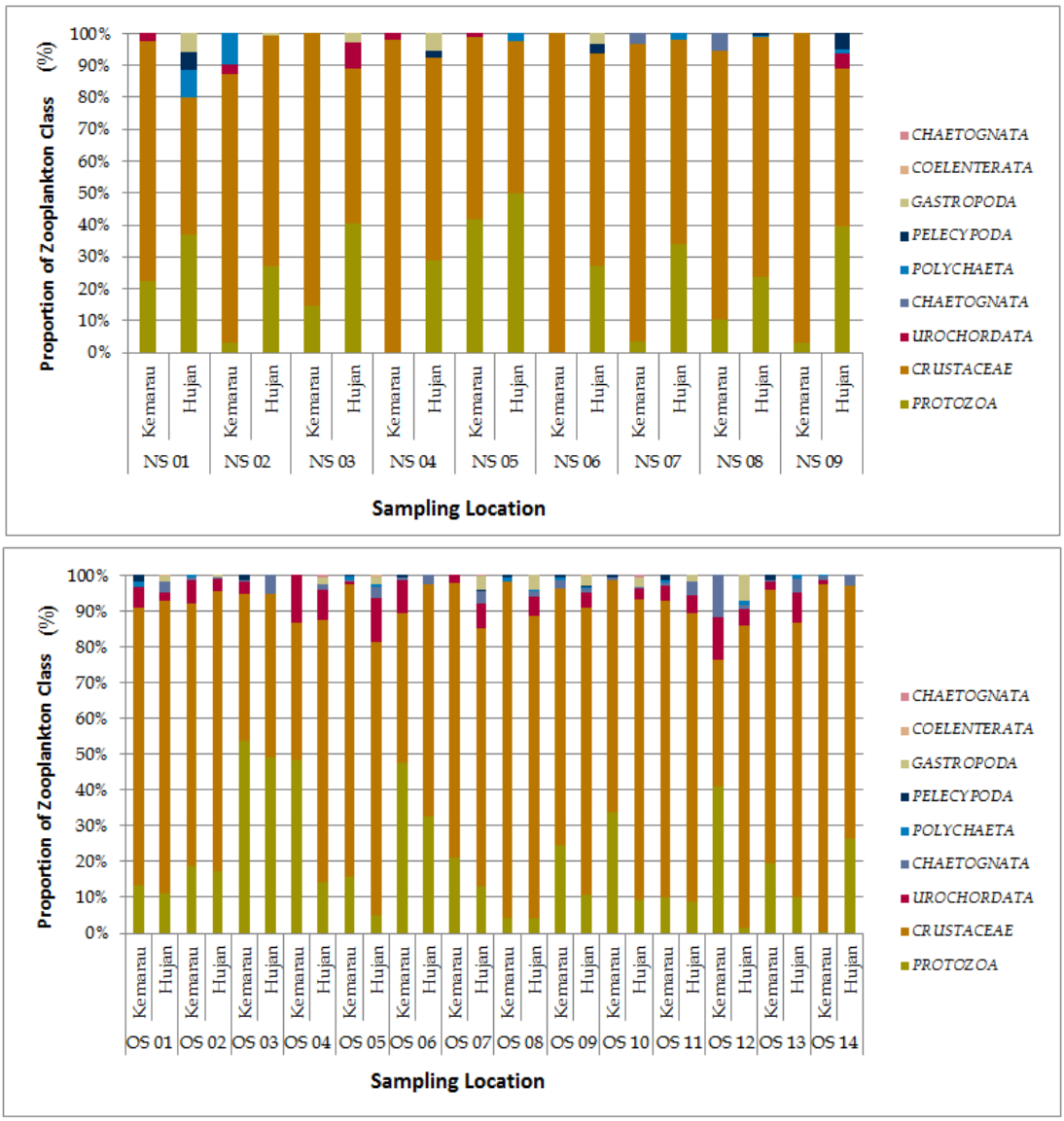


Figure II-163 **Proportion of the Zooplankton Class Abundance (%) at Each Seawater Observation Location (NS = Nearshore; OS = Offshore) in at the Study Area Comparing the Dry Season and Wet Season Conditions**

The existence of zooplankton in waters, in particular *crustacea* and various other microscopic organism is very important to ensure the continuity and balance of the ecosystem through the food chain mechanism. The zooplankton group as the first level consumers is very necessary for small fish and fish larvae, that in turn will provide food for the subsequent tropic level.

In general, the amount of zooplankton taxa in wet seasons tends to be more than in dry seasons. The range of taxa amount for the nearshore and offshore locations in the dry seasons are respectively 5 to 9 (nearshore) and 5 to 13 (offshore). For the same category, in the wet season a range of 6 to 13 (nearshore) and 7 and 20 (offshore) is obtained. It can be observed that the offshore location has a wider range with a taxa amount that tends to be more compared to the nearshore location (**Figure II-164** and **Figure II-165**).

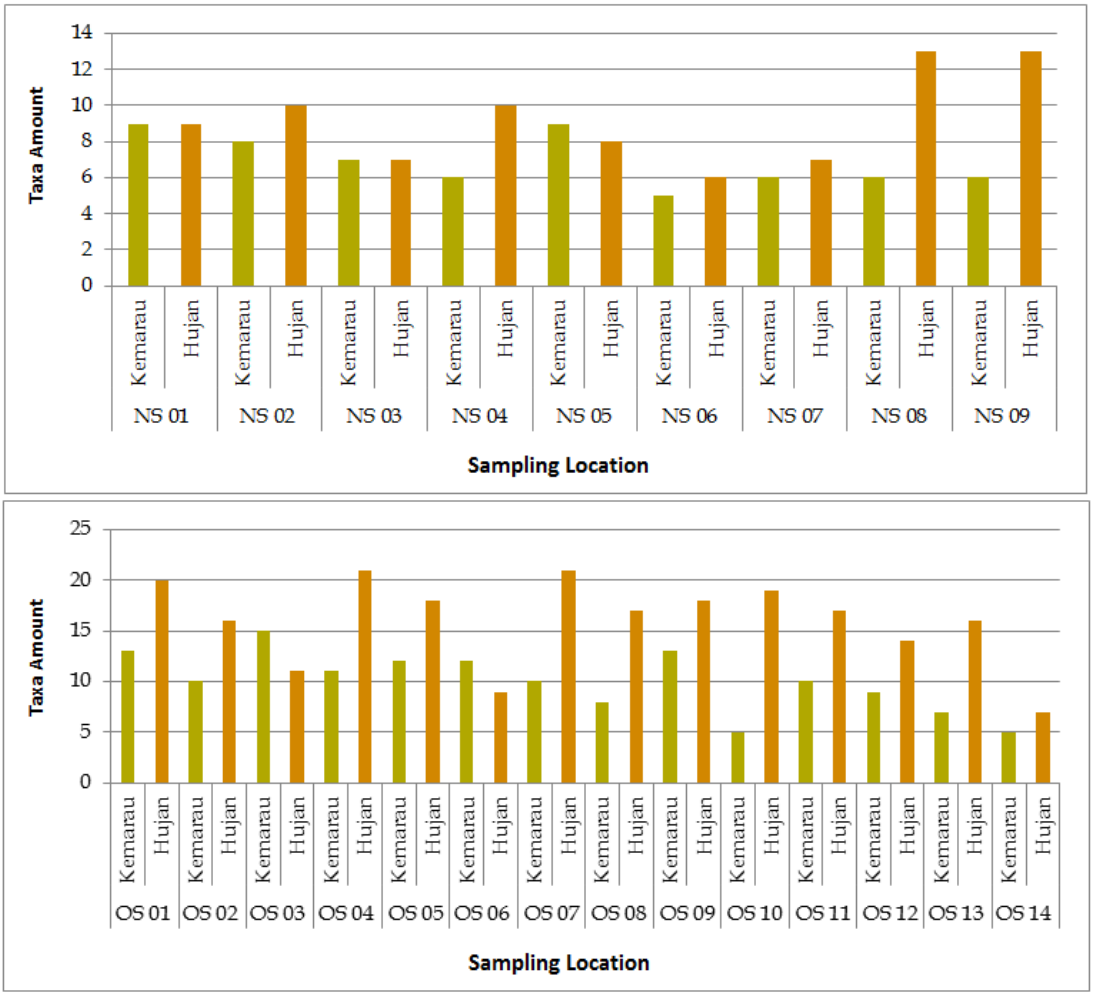


Figure II-164 **Amount of Zooplankton Taxa at Each Seawater Observation Location (NS=Nearshore; OS=Offshore) in the Study Area Comparing the Dry Season and Wet Season Conditions**

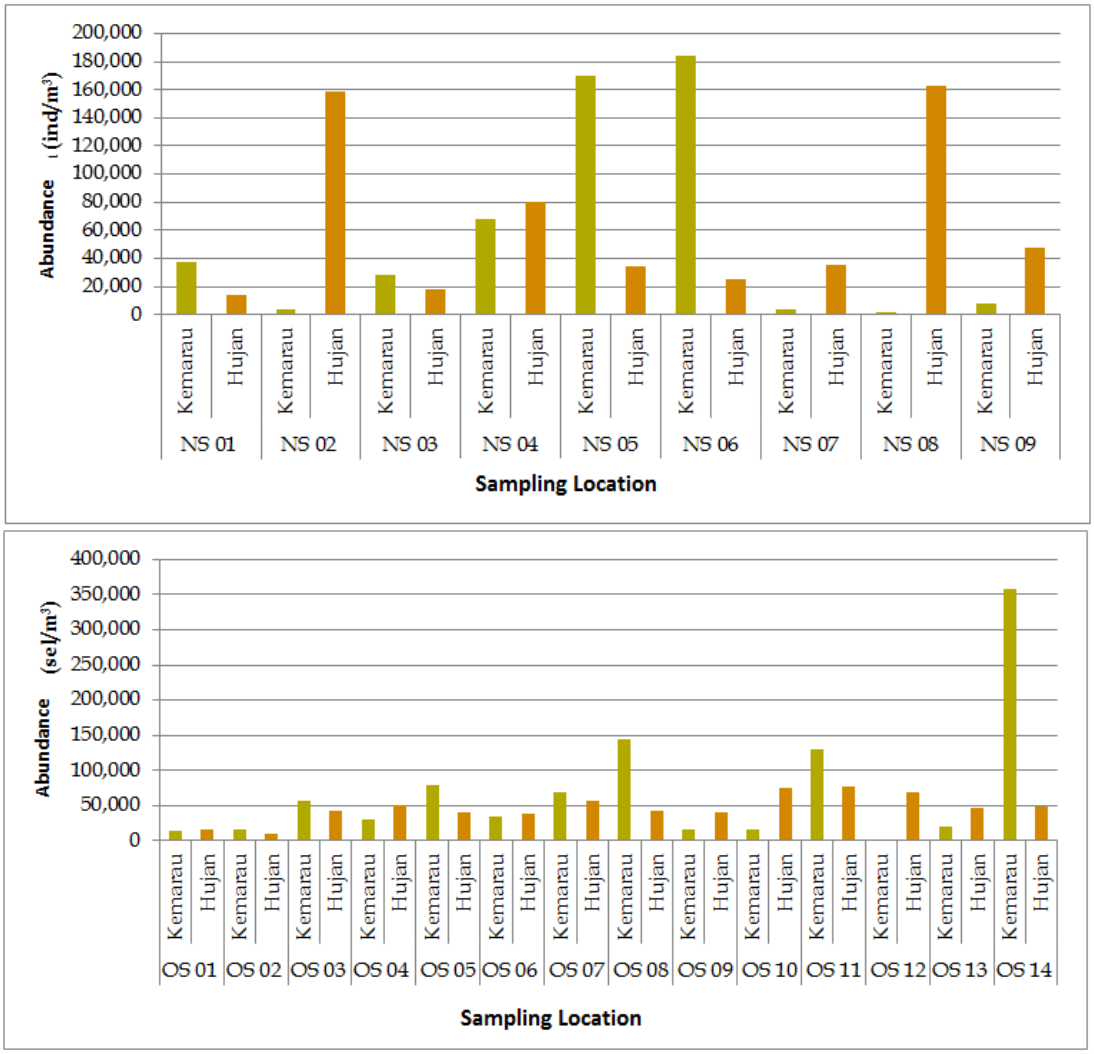


Figure II-165 **Zooplankton Abundance at Each Seawater Observation Location (NS=Nearshore; OS= Offshore) in the Study Area Comparing the Dry Season and Wet Season Conditions**

At all locations, the zooplankton abundance is not directly proportional to the taxa amount (**Figure II-164** and **Figure II-165**). The observation location with the highest zooplankton abundance is O-S14 (offshore, dry season), caused by the abundance domination of *Nauplia* early stadia from *copepod/crustacea* (**Figure II-166)**. the zooplankton abundance in general is < 100,000 cell/m^3, then between 100,000 – 200,000 cell/m^3 (NS-02, NS-05, NS-06, NS-08, OS-08, and OS-11) and > 200,000 cell/m^3 (OS-14).

Based on the type and amount, the zooplankton Diversity Index in the Bintuni Bay waters are in the range of 0.5 < H' < 2.0 (dry seasons) and 1.3 < H'< 2.4 (wet seasons) which is the 'Moderate' category. Either spatial or temporal, there are no significant differences between the observation locations for the H' value. The zooplankton distribution pattern tends to be uniform with a number of exceptions i.e. at points with the E index of < 0.6 (NS-04, OS-06 and OS-12) (**Figure II-168**).

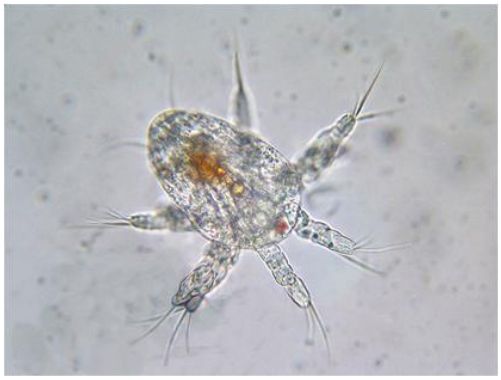


Figure II-166 ***Nauplius*** **larvae Prior to Become** ***Copepod,*** **One of the Food Sources of Small Fishes and Early Stadia in the Sea Ecosystem (Source: http://commons.wikimedia.org)**

Figure II-167 **Diversity Index (H') of Zooplankton Community at Each Seawater Observation Location (NS=Nearshore; OS=Offshore) in the Study Area Comparing the Dry Season and Wet Season Conditions**

Figure II-168 **Uniformity Index (E) of Zooplankton Community at Each Seawater Observation Location (NS=Nearshore; OS=Offshore) in the Study Area Comparing the Dry Season and Wet Season Conditions**

On the Sampling points with a higher H' Index value, have a lower c Index value. This condition means that the zooplankton community that have a low diversity have a high dominance index and vice versa. A number of locations have a c index of > 0.5 including NS-03, NS-04, NS-06 (nearshore), OS-05, OS-08, OS-13, OS-14 (offshore). Most of the high c value occurs during the dry seasons. Through data of the three indexes, it can be concluded that the water ecosystem condition based on the zooplankton community structure tends to be more stable during the wet season compared to dry season. This condition is similar to the case of phytoplankton community.

Figure II-169 **Dominance Index (c) of Zooplankton Community at Each Seawater Observation Location (NS=Nearshore; OS=Offshore) at the Study Area**

Abundance of Phytoplankton versus Zooplankton

The existence of phytoplankton (species, abundance and distribution) is apart from being controlled by physical factors such as currents and waves, are also affected or controlled by the existence of organism predator. Although not all phytoplankton are edible by zooplankton, but the domination of the *Protozoa* and *Bacillariophyceae* class indicate that the first link, namely the primary producers of the ecosystem are available. **Figure II-170** indicates the up and down of the abundance of phytoplankton and zooplankton that in general are observed tending to be directly proportional, with a few exceptions at a number of points. This can be the initial assumption for the consume-consuming process (grazing mechanisms) of phytoplankton by zooplankton. Nevertheless an in-depth study related to this phenomenon needs to be conducted.

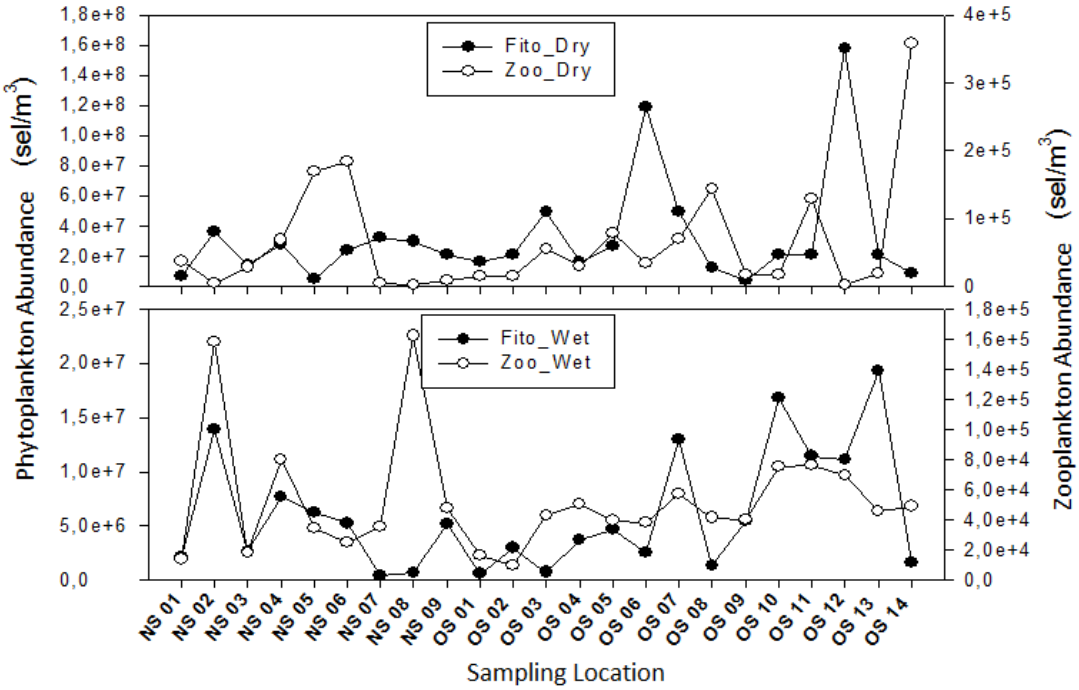


Figure II-170 Comparison of the Phytoplankton and Zooplankton Abundance (cell/m³) at Each Seawater Observation Point (NS = Nearshore; OS = Offshore) of the Study Area Comparing the Dry Season (Upper Panel) and Wet Season (Lower Panel) Conditions

Benthos

Benthos are organisms that live on or in the substrate base. In general, these basic organism occupy water habitats with soft substrates, that are suitable to their holing habits and the availability of high organic matters as a source of food. Observation results of the benthos organism, 12 benthos organism classes were obtained, which in general are dominated by *Polychaeta* and *Crustacea* (**Figure II-171**).

Polychaeta is a class of the *Annelida* worms that commonly live in the sea environment. Its body is of joints. On every joint are flesh bulges called *Parapodia. Parapodia* contains *chetae* that is made of *chitin* material. These worms are frequently called as bristle worms. A number of genera commonly found are *Lumbrineris, Nephthys, Notomastus* and *Prionospio* (**Figure II-172**). While genera found from the *Crustacea* class are the *Mysis* and *Metafoxus* (**Figure II-171).** The frequency found for other classes are very low.

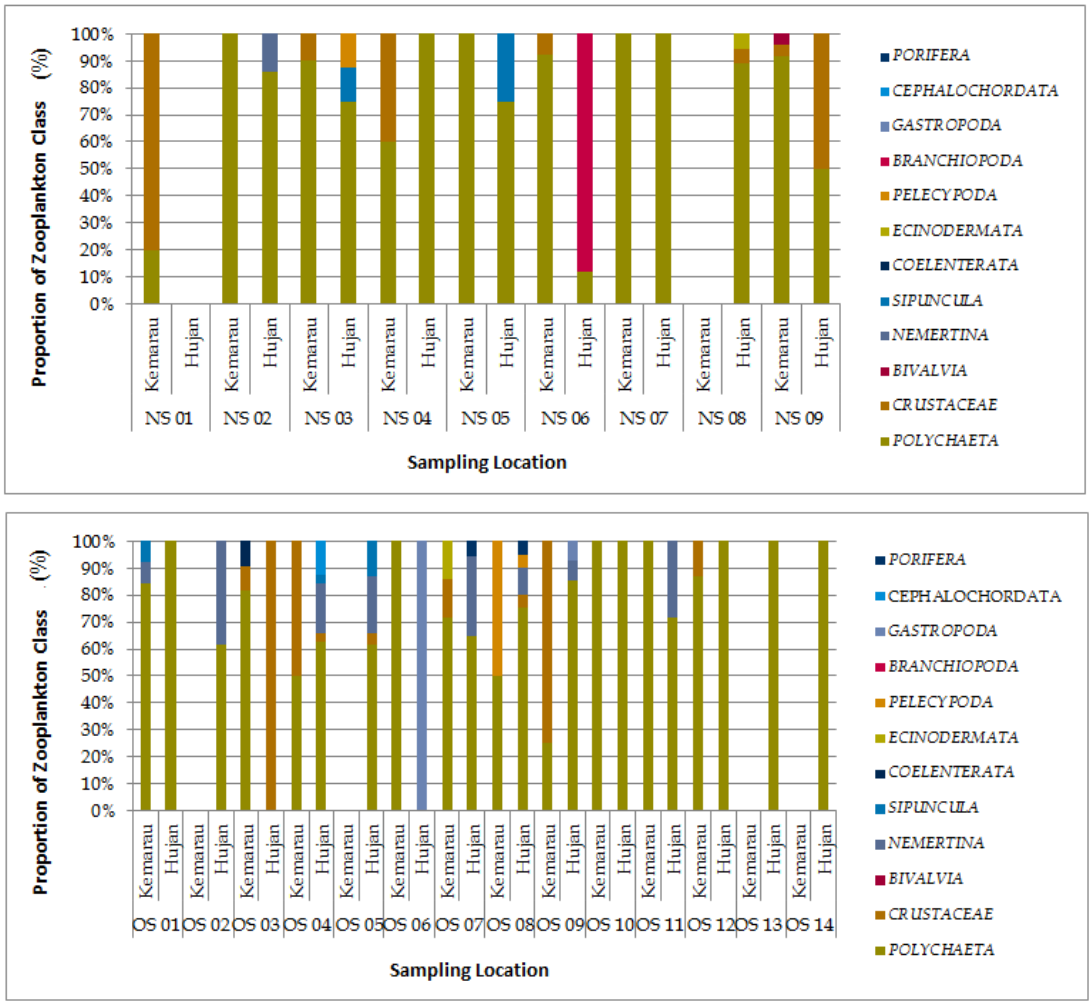
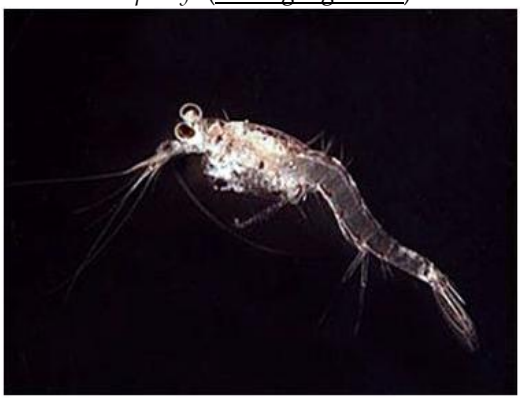


Figure II-171 **Abundance Proportion of the Benthos Organism Class (%) at Each Seawater Observation Location (NS = Nearshore; OS = Offshore) in the Study Area Comparing the Dry Season and Wet Season Conditions**

Lumbrineris (www.biorede.pt)

Nephthys (www.google.com)

Notomastus (www.google.com)



Mysis (www.google.com)

Figure II-172 Various Benthos Genera Found in the Study Area

Variability of the benthos taxa show differences between the nearshore and offshore locations, indicating fluctuations occurring at the offshore location that are higher compared to the nearshore. Temporally it is similar, the difference at the offshore location in dry seasons and wet seasons are more clear (**Figure II-174**). The number of benthos organism taxa in dry season range between 1 to 7 (nearshore) and 2 to 9 (offshore). In wet season, the number of taxa range for the two similar locations are 1 to 11 and 1 to 18. It is observed that the number of taxa in wet season has a wider range and the taxa number tends to be more (**Figure II-173** and **Figure II-174**)

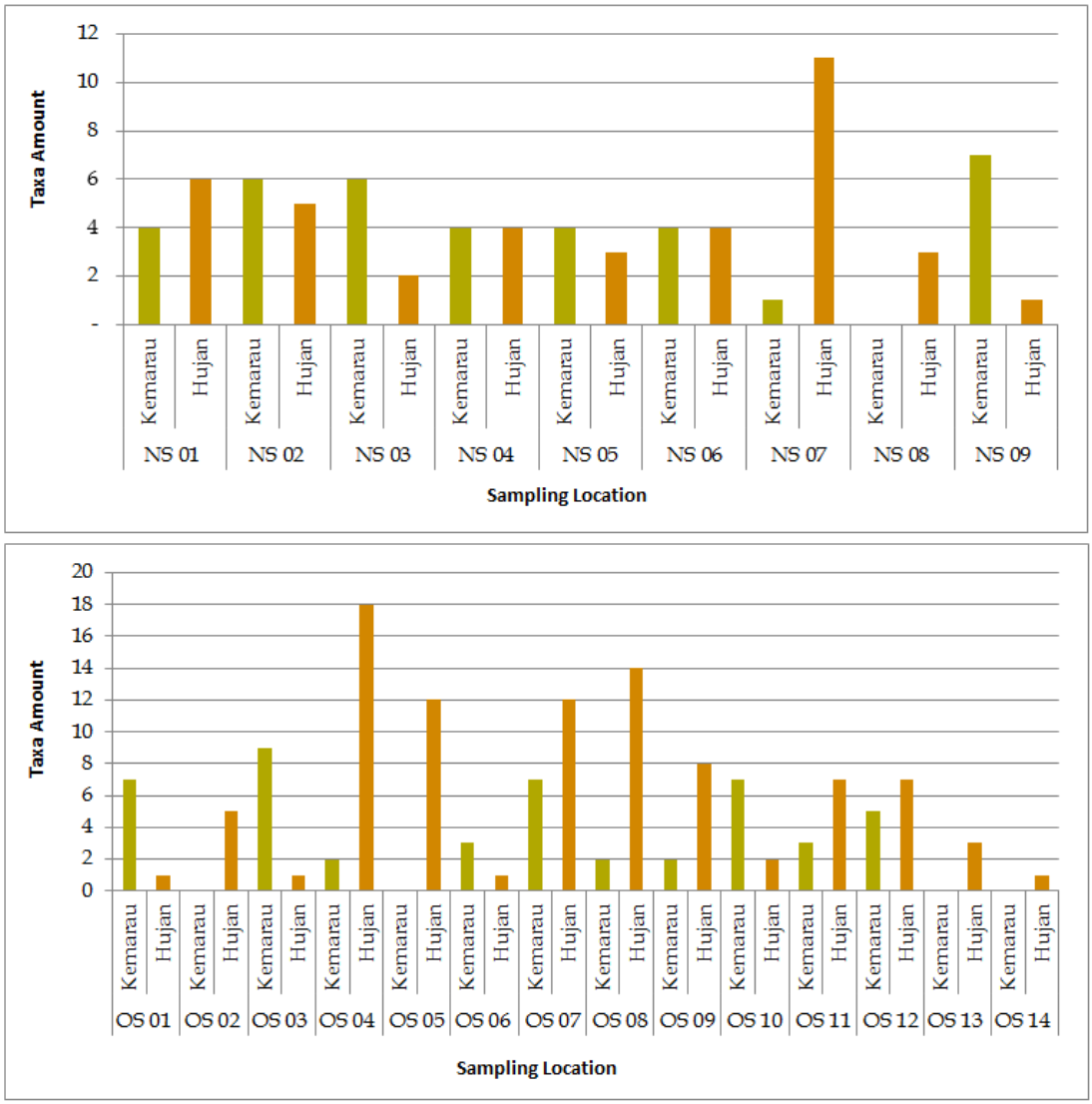


Figure II-173 **Number of Benthos Organism Taxa at Each Seawater Observation Location (NS=Nearshore; OS= Offshore) in the Study Area Comparing the Dry Season and Wet Season Conditions**

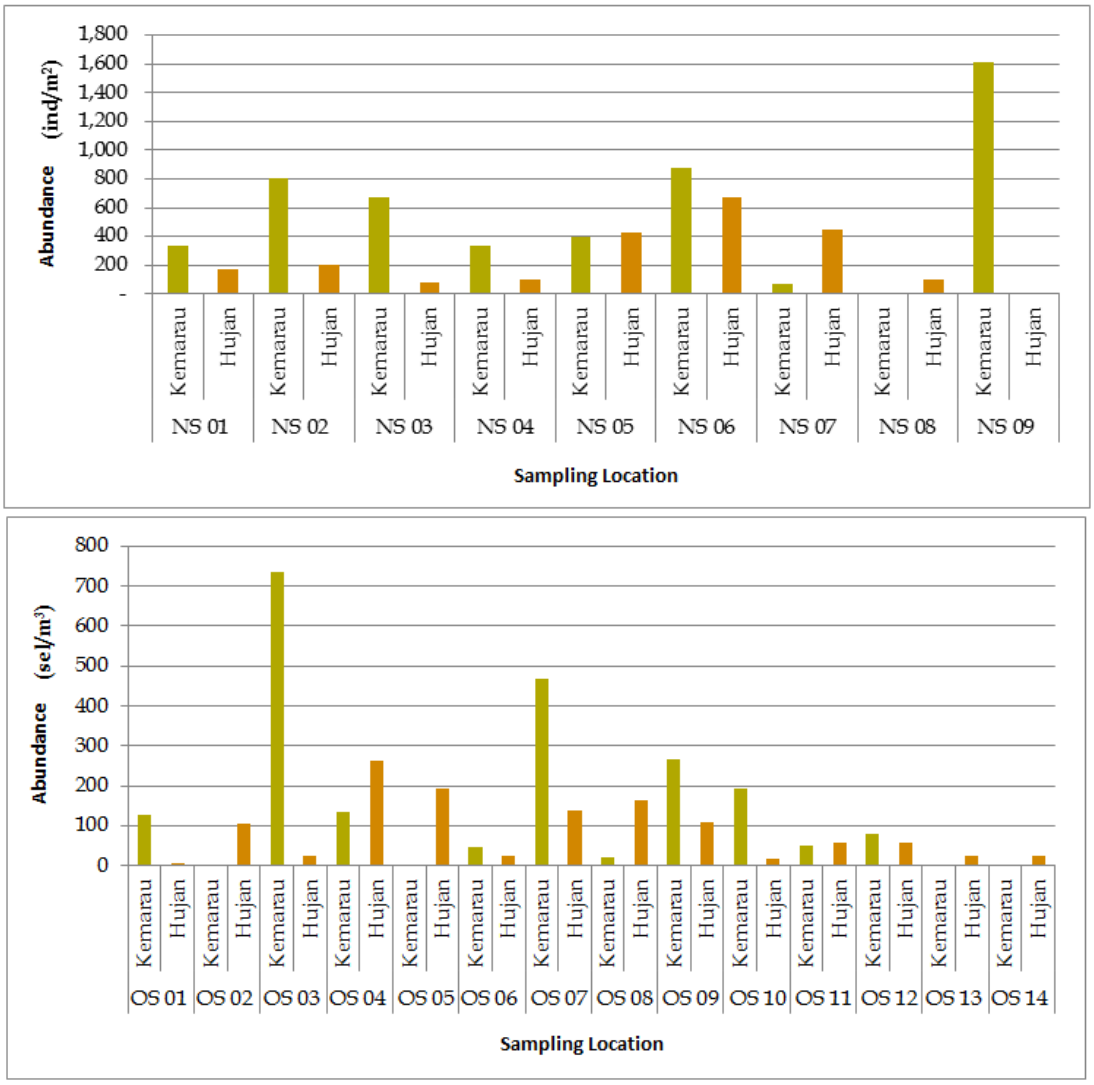
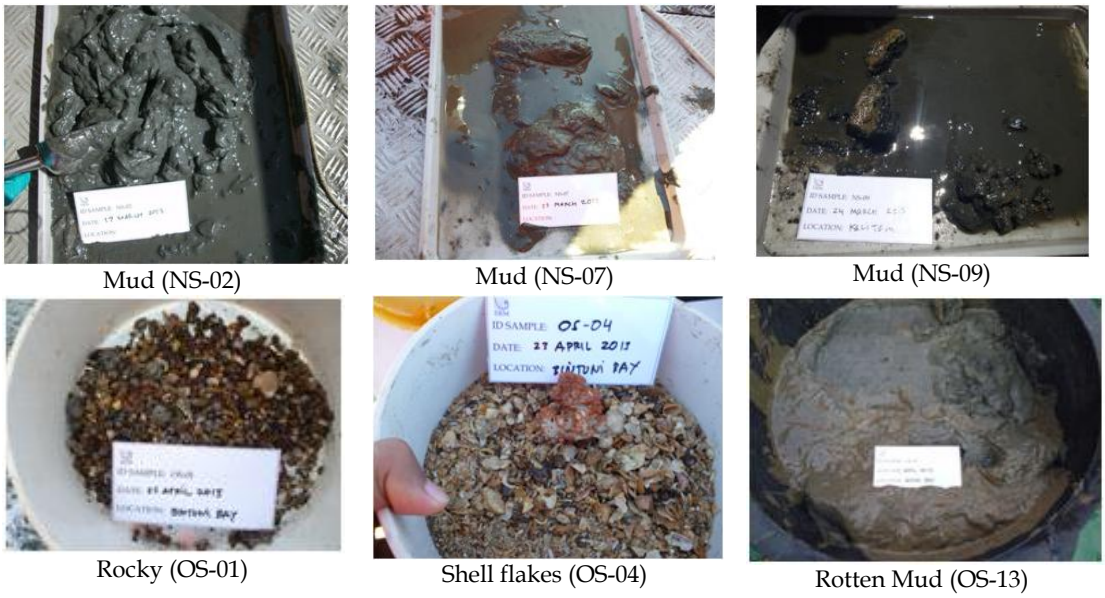


Figure II-174 **Benthos Animal Abundance at Each Seawater Observation Location (NS=Nearshore; OS= Offshore) in the Study Area Comparing the Dry Season and Wet Season Conditions**

Based **Figure II-173** and **Figure II-174** the benthos abundance condition between the dry seasons and wet seasons is not directly proportional to the taxa number. Stations with fewer numbers of taxa have a higher abundance. The difference of the taxa existence and its abundance depends on the substrate condition. In general, benthos organism are found in soft substrates i.e. muddy substrates. If the water oxygen still meet the minimum benthos physiological needs and the organic material content is available, then the benthos organism in particular the sea worms are widely found. A number of substrate types found in the study location are presented in **Figure II-175**.



Mud (NS-02) Mud (NS-07) Mud (NS-09)

Rocky (OS-01) Shell flakes (OS-04) Rotten Mud (OS-13)

Figure II-175 Various Substrate Types in Study Location

In muddy substrate that has a high abundance of benthos organisms in comparison to the rocky or muddy substrate type that is almost anoxic (very low oxygen) due to the decay of organic matter with very low or even non-existence of the benthos abundance.

The benthos Diversity Index indicates a high spatial and temporal fluctuation. In the dry seasons, the H' value is at range of 0.5 to 2.0 (nearshore) and 0.3 to 3.2 (offshore). In wet seasons, the similar location grouping is consecutively 0.6 to 3.2 (nearshore) and 1.0 to 3.8 (offshore) (**Figure II-176**) The H' value is a function of the number of species and its abundance, accordingly in natural conditions, the H' value depends on the substrate factor. Due to the existence of varying substrate types as presented in **Figure II-175**, it is considered that the condition represents its natural condition. The benthos organism distribution pattern is in general evenly, which indicates that the value of E > 0.5 is more often found in all observation points. Inversely proportional with H' is the dominance value, i.e. a low c value at a high H'.

Figure II-176 **Diversity Index (H') of the Benthos Community at Each Seawater Observation Location (NS=Nearshore; OS= Offshore) in the Study Area Comparing the Dry Season and Wet Season Conditions**

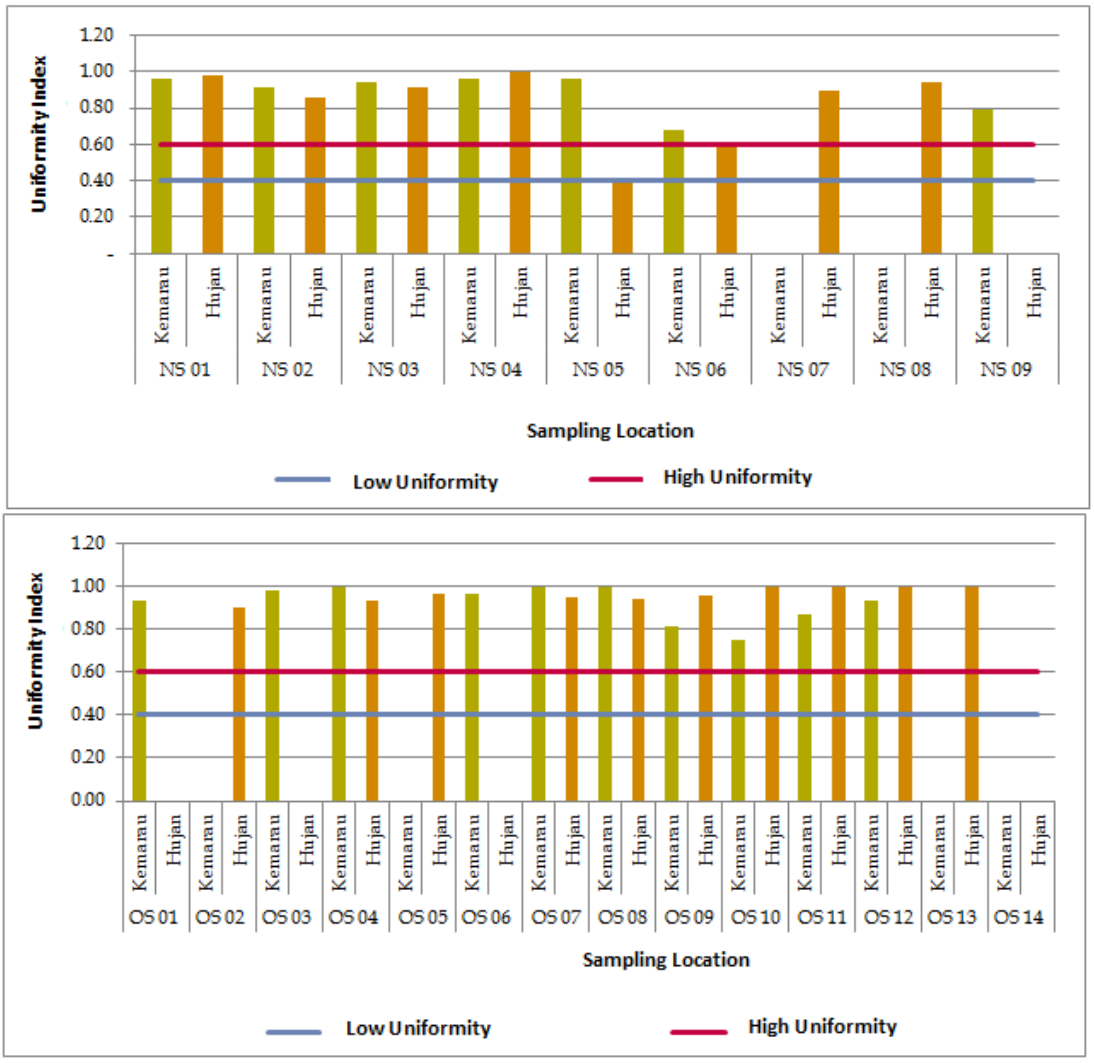


Figure II-177 Uniformity Index (E) of the Benthos Community at Each Seawater Observation Location (NS=Nearshore; OS= Offshore) in the Study Area Comparing the Dry Season and Wet Season Conditions

Based on assessments by using above biotic indexes, the benthos community structure tends to be less stable, affected by the substrate condition and seasonal factors. The low stability of benthos community is not due to disturbances to the ecological function of basic substrate but is presumably due to the natural conditions in study areas.

Figure II-178 Dominance Index (C) of the Benthos Community at Each Seawater Observation Location (NS = Nearshore; OS = Offshore) in the Study Area Comparing the Dry Season and Wet Season Conditions

2.2.2.3 Fisheries Resources

Data on fishery resources in the study area was compiled from secondary data of the Tangguh LNG fishery study reports in 2004, 2007 and 2009 and primary data through direct sampling that was performed in February – May 2103 by IPB (*Institiut Pertanian Bogor*) team and UNIPA (*Universitas Negeri Papua*) team as part of regular monitoring activities on Fishery Resources by the Tangguh LNG.

Fish Biodiversity

Based on data obtained from field survey results that conducted in February – May 2013, the amount of fish caught by fishing gear of gill nets, bottom trawl and pelagic trawl was 2,013 individuals. The number of species found are 82 species that are included in 33 families and 10 ordo.

Fish species that were caught are fish for consumption and are generally caught by local fishermen. In detail, the scientific names of the fish along with the families and ordo presented in **Table II-93.**

Table II-91 Fish Species Caught at Bintuni Bay Waters

No.	Ordo	No.	Family	No.	Species
1	*Carchariniformes*	1	*Carcharinidae*	1	*Carcharhinus macloti*
				2	*Carcharhinus sealei*
2	*Orectolobiformes*	2	*Stegostomatidae*	3	*Stegostoma fasciatum*
3	*Myliobatiformes*	3	*Dasyatidae*	4	*Himantura gerrardi*
4	*Clupeiformes*	4	*Engraulidae*	5	*Encrasicholina heteroloba*
				6	*Encrasicholina punctifer*
				7	*Encrasicolina* sp.
				8	*Setipinna taty*
				9	*Setipinna tenuifilis*
				10	*Stolephorus commersonii*
				11	*Stolephorus indicus*
				12	*Stolephorus waitei*
				13	*Thryssa baelama*
				14	*Thryssa encrasicholoides*
				15	*Thryssa hamiltonii*
				16	*Thryssa mystax*
				17	*Thryssa setirostris*
		5	*Pristigasteridae*	18	*Pellona ditchela*
		6	*Clupeidae*	19	*Amblygaster sirm*
				20	*Anodontostoma chacunda*
				21	*Escualosa thoracata*
				22	*Sardinella albella*
5	*Siluriformes*	7	*Ariidae*	23	*Arius argyropleuron*
				24	*Arius armiger*
				25	*Arius graeffei*
				26	*Arius leptaspis*
				27	*Netuma thalassina*
		8	*Plotossidae*	28	*Paraplotosus albilabris*
				29	*Plotosus lineatus*
6	*Aulopiformes*	9	*Synodontidae*	30	*Harpadon nehereus*
				31	*Saurida tumbil*
7	*Mugiliformes*	10	*Mugilidae*	32	*Moolgarda engeli*
8	*Perciformes*	11	*Ambassidae*	33	*Ambassis nalua*
		12	*Apogonidae*	34	*Apogon cyanosoma*
		13	*Sillaginidae*	35	*Sillago sihama*

No.	Ordo	No.	Family	No.	Species
		14	*Carangidae*	36	*Alepes vari*
				37	*Carangoides chrysophrys*
				38	*Caranx bucculentus*
				39	*Caranx ignobilis*
				40	*Decapterus kurroides*
				41	*Megalaspis cordyla*
				42	*Parastromateus niger*
				43	*Scomberoides tol*
				44	*Selaroides leptolepis*

Source: IPB, 2013

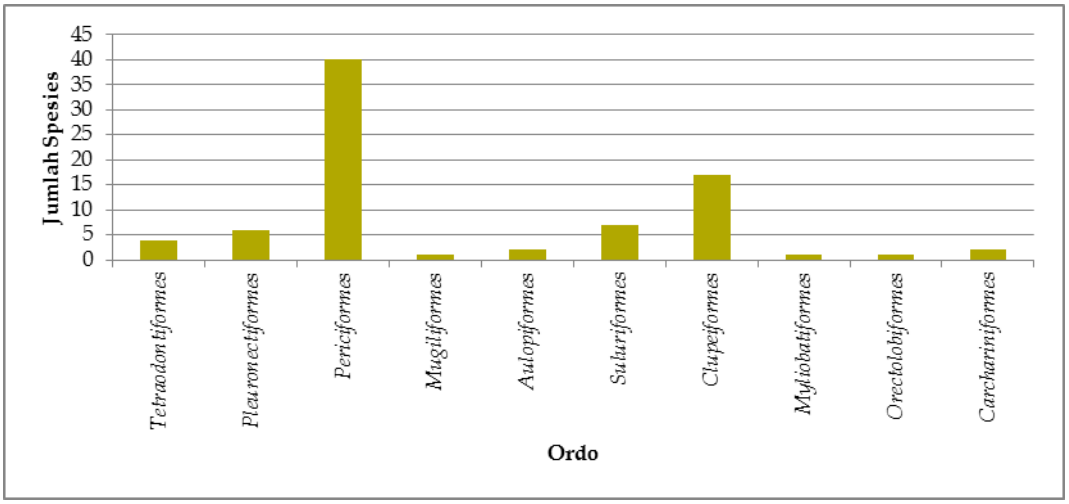


Figure II-179 Distribution of Species in Ordo

Based on **Figure II-179**, the *Perciformes* ordo has most families. This condition can be understood as this ordo has many families in the entire waters of the world.

Fish Distribution

Classification of study locations in fisheries studies conducted by IPB in 2013 indicates a number of survey zones, i.e. the inner zones, central zones and outer zones (**Figure II-180**).

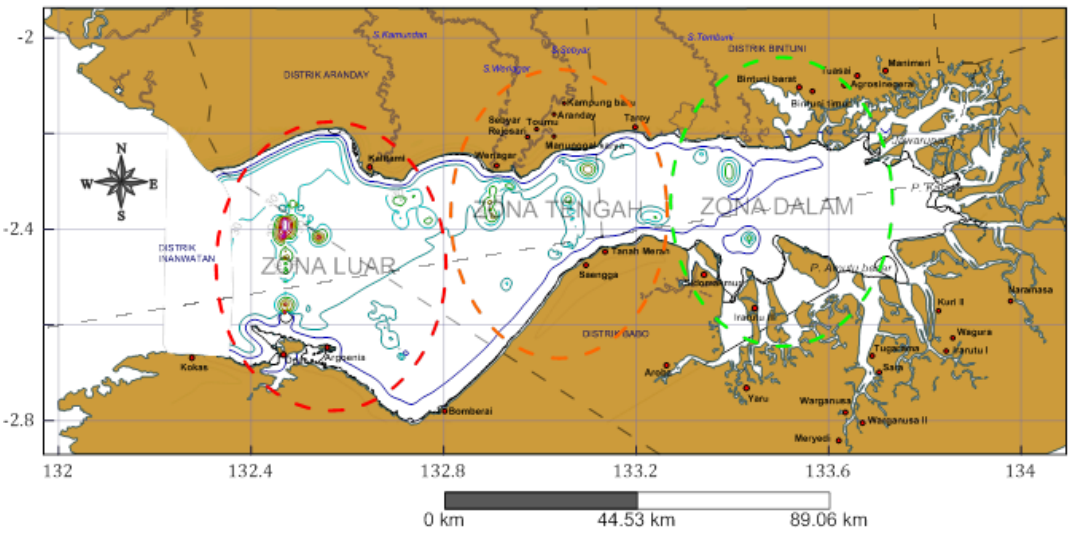


Figure II-180 Classification of Study Zones

Based on observations in the study zones, the number of fish species were mostly found in Inner Zone, Central Zone and Outer Zone (mouth of the bay). The number of species found in the Inner Zone were 46 species, and many species were found among others *Caranx ignobilis*, *Carcharhinus macloti*, *Himantura gerrardi*, *Megalaspis cordyla* and *Sphyraena barracuda*. The whole fishes found are sea fishes on average. The number of species in Central Zone and Inner Zone are 32 species and 35 species, which fish species frequently found are among others *Arius argyropleuron*, *Arius graeffei*, *Paraplotosus albilabris*, *Plotosus lineatus*, and *Scatophagus argus*. These species are sea fish and estuary fish species (**Table II-94**).

Table II-92 Distribution of Fish in Each Survey Zone

No.	Species	Outer Zone	Central Zone	Inner Zone	Ecological Category
1	*Carcharhinus macloti*	+	+	+	L
2	*Carcharhinus sealei*	-	-	+	L
3	*Stegostoma fasciatum*	-	+	-	Est. (L)
4	*Himantura gerrardi*	+	-	-	L
5	*Encrasicholina heteroloba*	+	-	-	L
6	*Encrasicholina punctifer*	-	+	-	L
7	*Encrasicolina* sp.	+	-	-	L
8	*Setipinna taty*	+	-	-	L
9	*Setipinna tenuifilis*	+	+	+	Est. (L)
10	*Stolephorus commersonii*	-	+	-	Est. (L)
11	*Stolephorus indicus*	+	-	-	L
12	*Stolephorus waitei*	+	+	-	Est. (L)
13	*Thryssa baelama*	+	+	-	Est. (L)
14	*Thryssa encrasicholoides*	-	-	+	Est. (L)
15	*Thryssa hamiltonii*	+	+	-	Est. (L)
16	*Thryssa mystax*	-	-	+	Est. (L)
17	*Thryssa setirostris*	+	+	+	Est. (L)

No.	Species	Outer Zone	Central Zone	Inner Zone	Ecological Category
18	*Pellona ditchela*	-	-	+	Est. (L)
19	*Amblygaster sirm*	+	-	-	L
20	*Anodontostoma chacunda*	-	+	-	Est. (L)
21	*Escualosa thoracata*	+	+	+	Est. (L)
22	*Sardinella albella*	-	-	+	Est.
23	*Arius argyropleuron*	-	+	+	Est.
24	*Arius armiger*	-	-	+	Est.
25	*Arius graeffei*	-	+	+	Est.
26	*Arius leptaspis*	-	-	+	Est.
27	*Netuma thalassina*	-	-	+	Est.
28	*Paraplotosus albilabris*	-	-	+	Est.
29	*Plotosus lineatus*	-	-	+	Est.
30	*Harpadon nehereus*	+	-	-	L
31	*Saurida tumbil*	+	-	+	Est. (L)
32	*Moolgarda engeli*	+	-	-	Est. (L)
33	*Ambassis nalua*	-	-	+	Est.
34	*Apogon cyanosoma*	+	-	+	Est.
35	*Sillago sihama*	-	+	+	Est. (L)
36	*Alepes vari*	-	-	+	L
37	*Carangoides chrysophrys*	+	+	-	L
38	*Caranx bucculentus*	-	+	-	L
39	*Caranx ignobilis*	+	-	-	L
40	*Decapterus kurroides*	-	+	-	L
41	*Megalaspis cordyla*	+	-	-	L
42	*Parastromateus niger*	-	+	-	L
43	*Scomberoides tol*	-	-	+	Est.
44	*Selaroides leptolepis*	+	-	-	L
45	*Ulua mentalis*	-	+	-	L
46	*Eubleekeria splendens*	+	+	+	Est. (L)
47	*Leiognathus bindus*	-	-	+	Est. (L)
48	*Leiognathus decorus*	-	-	+	Est. (L)
49	*Leiognathus equulus*	-	+	+	L
50	*Secutor ruconius*	+	+	+	Est. (L)
51	*Lutjanus argentimaculatus*	-	-	+	Est.
52	*Lobotes surinamensis*	-	+	-	Est. (L)
53	*Pomadasys argyreus*	-	-	+	Est.
54	*Pomadasys kaakan*	-	-	+	Est.
55	*Eleutheronema tetradactylum*	+	-	-	L
56	*Johnius amblycephalus*	-	-	+	Est.
57	*Johnius australis*	+	-	-	Est. (L)
58	*Johnius belangerii*	+	+	+	Est. (L)
59	*Johnius sp.*	-	+	-	Est. (L)
60	*Nibea soldado*	+	+	+	Est. (L)

No.	Species	Outer Zone	Central Zone	Inner Zone	Ecological Category
61	*Protonibea diacantha*	-	-	+	Est.
62	*Upeneus moluccensis*	-	-	+	Est. (L)
63	*Upeneus sulphureus*	-	-	+	Est. (L)
64	*Drepane longimana*	-	+	+	Est. (L)
65	*Drepane punctata*	-	+	+	Est. (L)
66	*Terapon theraps*	-	+	+	Est. (L)
67	*Brachyamblyopus coecus*	-	-	+	Est. (L)
68	*Kurtus gulliveri*	-	-	+	Est.
69	*Scatophagus argus*	-	-	+	Est.
70	*Lepturacanthus savala*	-	+	+	L
71	*Scomberomorus commerson*	-	+	-	L
72	*Sphyraena barracuda*	+	-	-	L
73	*Psenopsis humerosa*	-	-	+	Est. (L)
74	*Aseraggodes klunzingeri*	+	-	-	L
75	*Zebrias zebra*	-	-	+	Est. (L)
76	*Cynoglossus cynoglossus*	-	+	-	L
77	*Cynoglossus lingua*	-	-	+	Est. (L)
78	*Cynoglossus puncticeps*	-	+	-	L
79	*Paraplagusia bilineata*	+	+	-	Est. (L)
80	*Triacanthus sp.*	+	-	-	L
81	*Tripodichthys blochii*	-	+	-	L
82	*Lagocephalus inermis*	+	-	-	L
Total		**32**	**35**	**46**	

Source: IPB, 2013
Remarks:
Est. = Estuary
L = Sea

Based on the ecological category, fishes found are classified into three groups. The first group is marine species group, then the groups that are able to live in the sea and estuaries (sea-estuary) and the third group is estuary species. Based on groups, the estuary (sea) fish groups are known to dominate the Bintuni Bay waters.

In the ecological groups, data obtained indicate that estuary fishes are more common found in Inner Zone compared to Central Zone. The estuary fishes in Central and Inner Zone are more affected by salinity of the zones. The salinity in Central and Inner Zones are relatively lower compared to Outer Zone allowing fishes that usually inhabit estuaries can be found in the two zones.

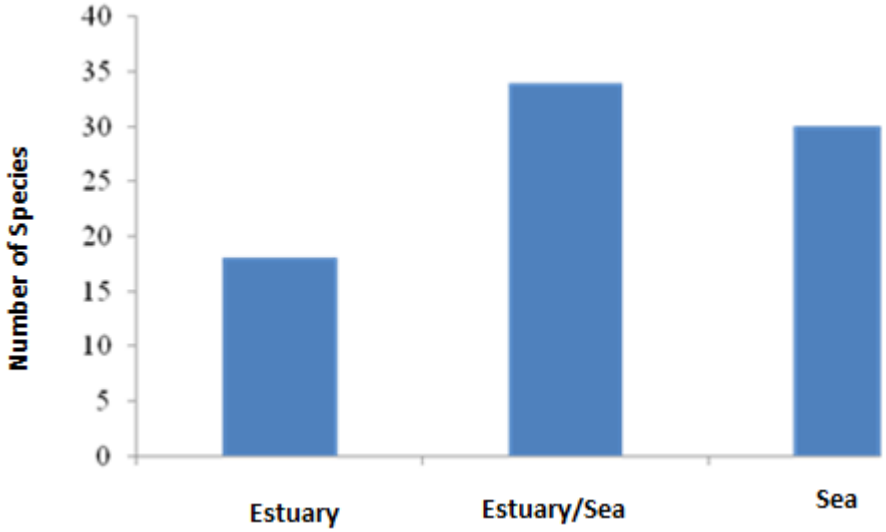


Figure II-181 Fish Species Distribution Based on Ecological Category

Potential Fish Resources

Calculation of potential fish resources was conducted by hydro-acoustic method. Hydro-acoustic is a set of sounder instruments and computer that operated by surveyors' team. The instrument recorded the existence of all organisms in water columns and bottom of waters that was passed. While to identify fish species recorded by acoustic instrument, trawl gear and gill-net are also simultaneously operated. The operation of the instrument is conducted at the predetermined survey track as presented in **Figure II-182.**

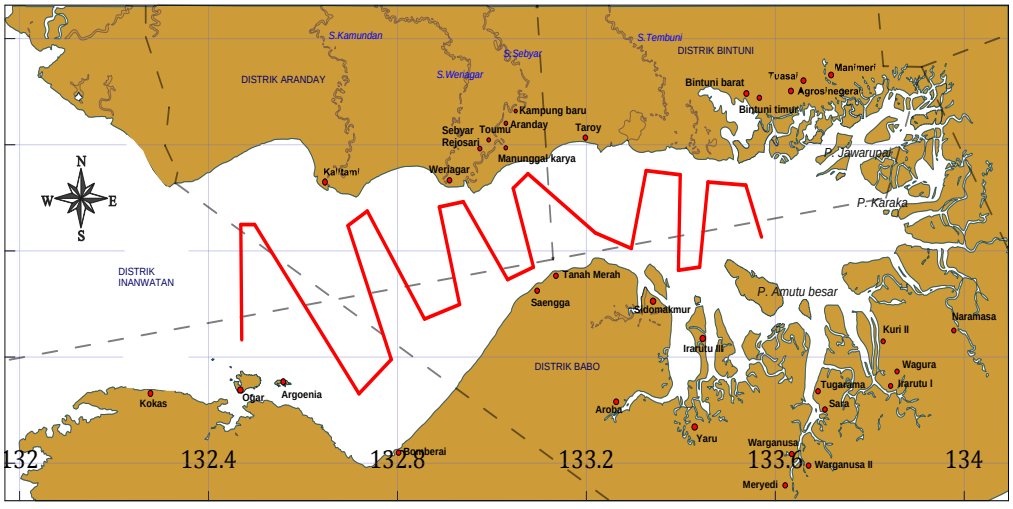


Figure II-182 Track of Fish Survey Conducted by IPB Team on April 30th – May 5th, 2013

The length of survey track is 343.52 km, starting from the mouth of the Bintuni Bay (towards the west) to the inner side of the bay, up to the Amutu Besar island water areas (towards the east).

A number of fish species found during the hydro-acoustic survey can be observed in **Figure II-183.**

Based on analysis results of acoustic data, a shoal of fish was found which it is categorized into two type, namely the pelagic fish (present in the water column) and demersal fish (present near the water floor). In the pelagic fish areas a strata division was conducted with interval of 10 m, so that six depth strata were obtained. Demersal fish is limited to the waters column at depth of 5 m from the water floor.

Analysis results in terms of fish density/abundance at survey track based on depth can be observed in **Figure II-184**. Density data of fish resources stock (ρ) at an area can be used to know the fish biomass (Bo) or Standing Stock based on the formula [Bo = A x ρ], wherein A is the total study area.

The Standing Stock of a certain biota can provide an estimate of the biota Potential yield (Py) in the waters. The Potential yield is the maximum catch estimation (ton/year) of certain waters without disturbing the existing resource sustainability. The equation used to calculate the Py value is as follows:

$$Py = Bo \times 50\% \times 80\ \%$$

The average of Potential yield fish resources per year in Bintuni Bay areas, can be calculated by identifying the extent of study area per depth strata. The depth strata is divided into seven depth strata with an interval of 10 meter, but the demersal layer is measured 5 meter from the water floor.

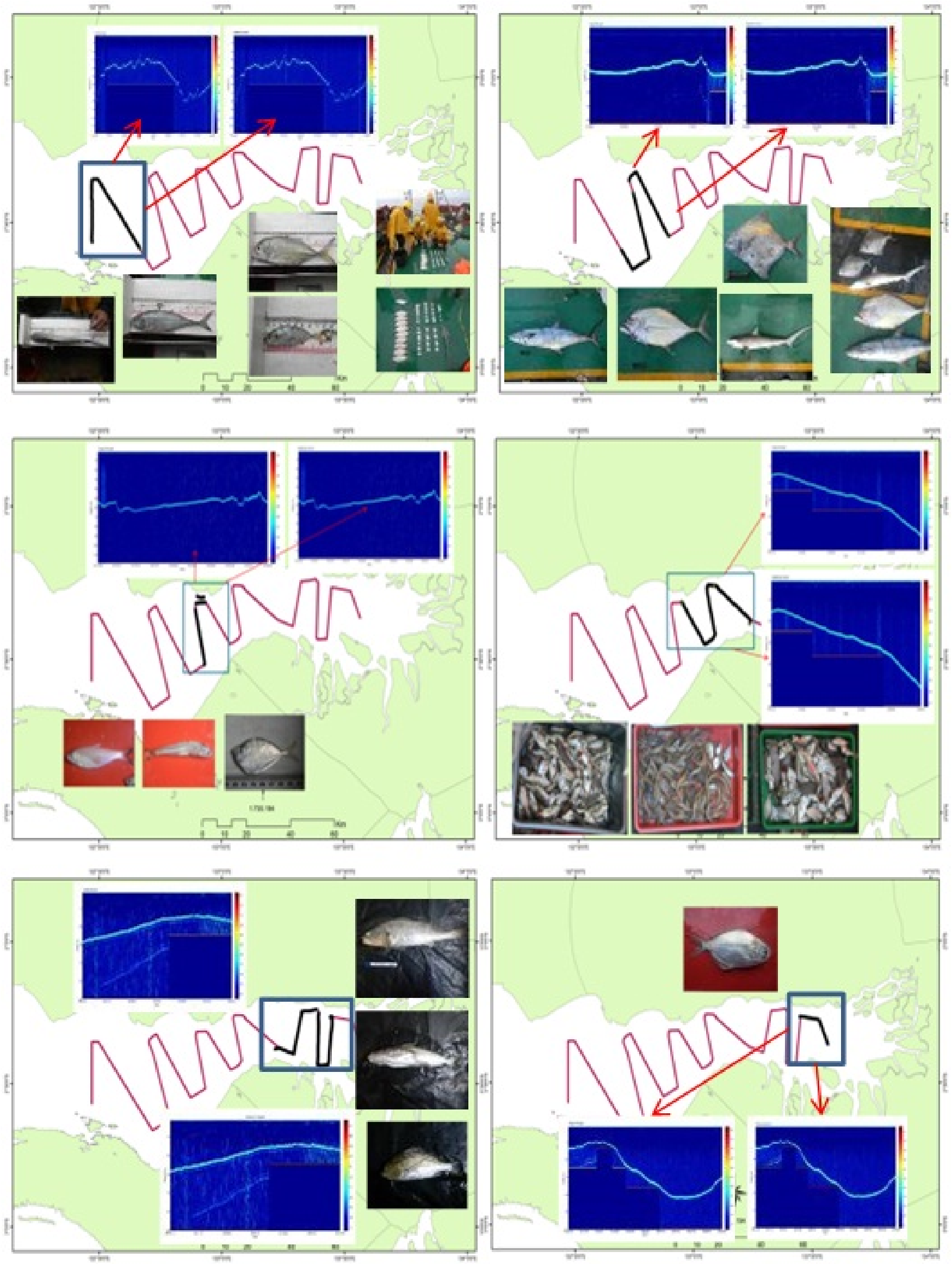


Figure II-183 Measurement Results of Fish Density by Hydro-acoustic and a Number of Fish Specimen Examples Caught in the Survey Track (IPB, 2013)

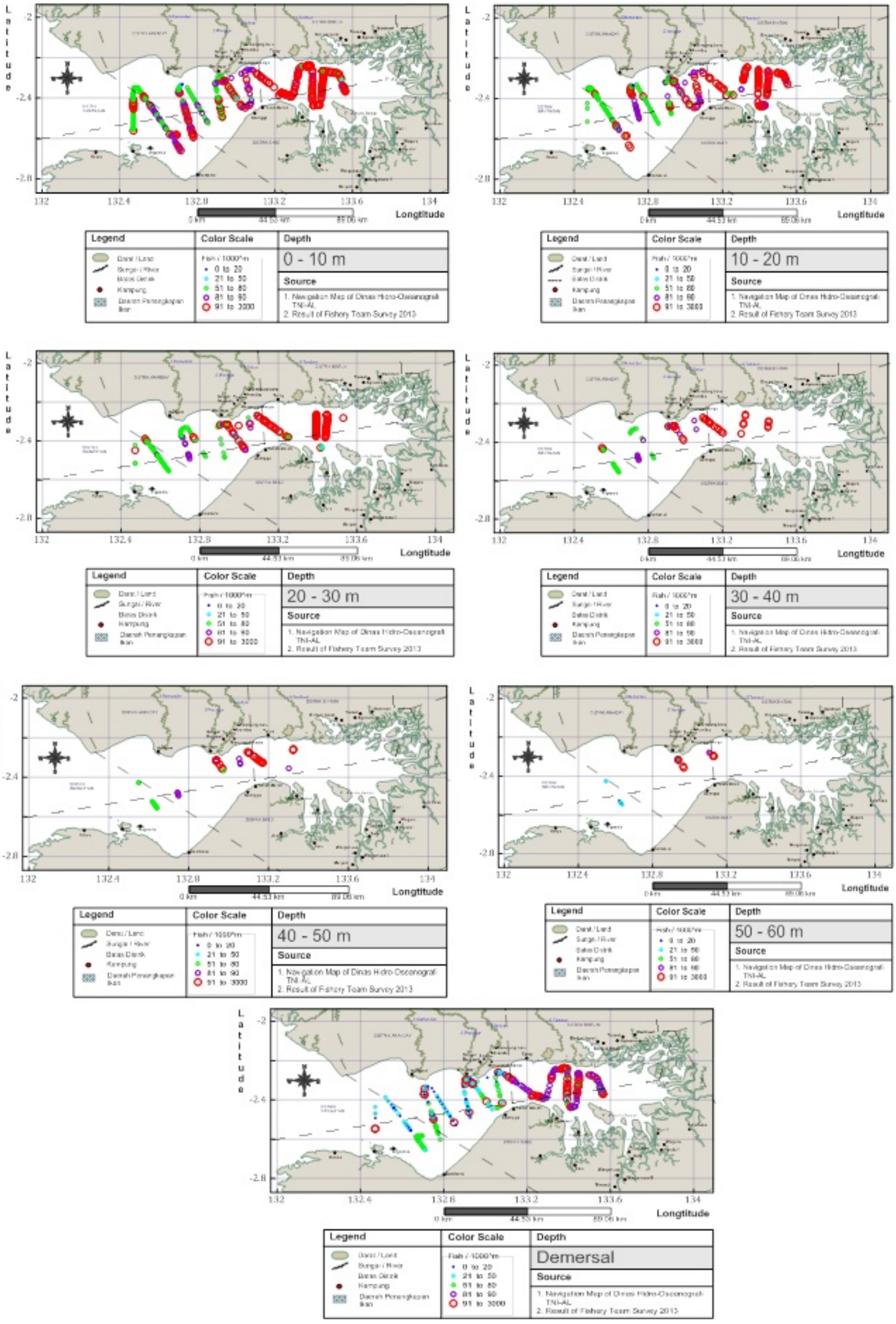


Figure II-184 Fish Abundance in the Survey Track Based on Depth (IPB, 2013)

Based on digitized calculations to the bathymetry Map of Bintuni Bay, area of waters based on depth strata was obtained as presented in **Table II-95**. The fish Density (Stock Density), Standing Stock and Potential Yield were calculated from the total Bintuni Bay water areas at every depth strata as presented in **Table II-96.**

Table II-93 Area of Bintuni Bay Waters Based on the Depth Strata

Depth Strata (meter)	Area (km^2)
0 – 10	2,553
10 – 20	2,301
20 – 30	1,838
30 – 40	1,277
40 – 50	839
50 – 60	421
Demersal	2,671
Total Area	**11,900**

Source: Processed from Bintuny Bay Hydro-acoustic Survey Data 2013 (IPB, 2013)

Table II-94 Fish Density and Standing Stock in Bintuni Bay Based on Depth

Depth Strata (meter)	Width (km^2)	Density (ton/km^2)	Standing Stock (ton)	Potential Yield (ton/yr)
0 – 10	2,553	0.237	605	242
10 – 20	2,301	0.765	1,760	704
20 – 30	1,838	0.465	855	342
30 – 40	1,277	0.078	100	40
40 – 50	839	0.042	35	14
50 – 60	421	0.020	8	3
Demersal	2,671	1.050	2,804	1,122
Total	**11,900**		**6,167**	**2,467**
Average		**0.380**		

Source: Processed from Bintuni Bay Hydro–acoustic Survey Data 2013 (IPB, 2013)

Based on survey results in 2013, the average stock density value (ton/km^2) of fish in Bintuni Bay is 0.380 ton/km^2. When compared to potential fish in 2004 which averagely is 0.2468 ton/km^2 (UNIPA, 2004), hence there was a stock density increase of the average potential fish. The condition in 2004 is likely due to at the period, the number of trawling fishermen was quite high, however currently many trawl fishermen quitted so that it can increase the potential fish at the site. This condition can be observed from the survey results in 2013 stating that many fish regeneration that live in almost all types were found.

When observed from the potential yield value obtained in 2007 i.e. 1,190 (ton/year) and during the survey in 2013 namely 2,467 (ton/year), then it can be indicated that there was an increase which it is due to the extensive survey area covering almost the entire Bintuni Bay areas as well as the survey was conducted *insitu*.

Fishing Areas

Determination of the fishing areas in the Bintuni Bay can be obtained from analysis results between map of the fish shoal Distribution (from the survey results) and map of water depth as well as other supporting factors of field survey observation results.

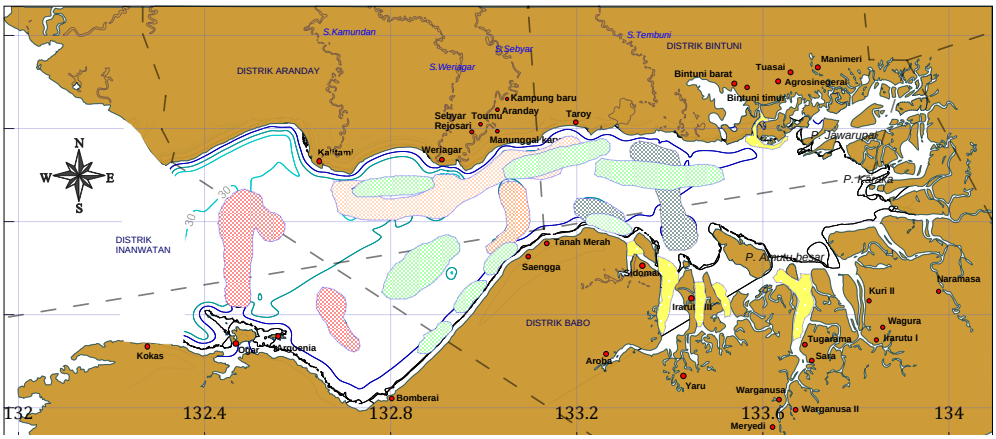


Figure II-185 Map of Fishing Areas, Survey Results in 2013 (IPB, 2013)

The fishing areas in the Bintuni Bay are divided into five classes based on commodities that are present in the location, namely:

Class 1: The red shading is fishing area for marine fish species. Located in the northern of Ogar Island and eastern of Arguni Island. Fish commodities in this class are among others, Giant Travelly, Pomfret, Mackerel, Tuna, Sharks, *Layang* Fish, Threadfin and *Kembung* Fish.

Class 2: The orange shading is fishing areas of mixed fish between brackish and marine fishes. The fishing location is in the surroundings of Weriagar, Manunggal Jaya, Taroy, Kalitami, Saengga and Tanah Merah. Fish commodities in this class are among others, the Ponyfish, Croaker, Sardine, Veined Catfish, Anchovy, Terapon, travelly, estuarine lobsters and estuarine shrimp species.

Class 3: The blue shading is fish areas living in water locations with greater fresh water affect. It is located in the areas of Amutu Besar Island, Sidomakmur and Irarutu III. Veined Catfish and Ponyfish are most commodities found in these areas.

Class 4: Shrimp catching areas. Marked in green, the catching areas spread-out on the Bintuni Bay, covering the Tanah Merah, Saengga, Weriagar, Manunggal

Karya and Taroy areas. Shrimp species mostly found are among others, the *Sima* Shrimp, *Banana* Shrimp and *Ende* Shrimp (in the local language).

Class 5: Crab catching areas (yellow color). In general, it is located at river estuaries, such as Sidomakmur, Irarutu III, Bintuni and around estuary of Amutu Kecil Island

Based on survey results in 2007, fishing grounds for local fishermen cover almost all creeks/channels affected by tidal waters (estuaries).

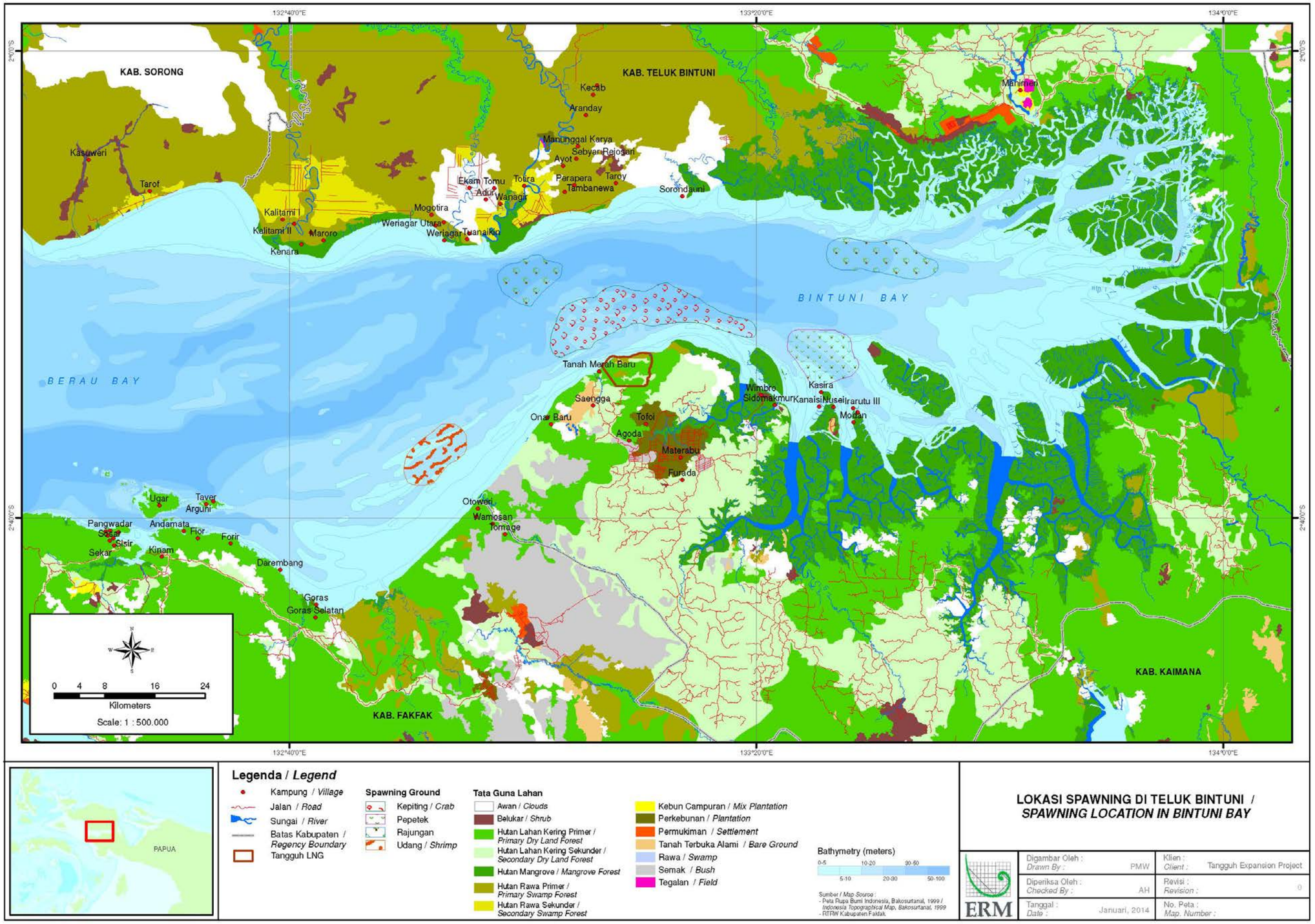
Bed gillnets are operated along the coastal waters near local villages, in large rivers and large estuaries. The operations of bed gillnets in these areas are almost always performed during neap water, which occurs at the lowest tide. When the distance between high tide and low tide is low, the installation of bed gillnets are conducted at creeks.

Shark nets are frequently operated in waters up to a depth of 30 m, however it is not infrequently also operated in rivers. Drift gillnets such as mackerel nets and lema fish nets (I) are operated in open waters starting in the surroundings of the Karaka Island up till the waters near Weriagar-Mogotira.

Bed trawl (longline) at Mogotira-Weriagar is operated in a depth of around 10 m, close to river mouths. Fishermen from Manggarina are even capable to operate bed longlines to a depth of 30 m. Fishermen from East Bintuni operate this instrument up till waters in the surroundings of the Karaka Island, or in rivers in the eastern Bintuni Bay waters.

In 2013 an increase occurred in the demand for shrimp and mangrove crabs in the market so that many fishermen changed to catch shrimps or mangrove crabs. **Figure II-186.** Are some examples of non-fish resources such as shrimps, crabs and mollusks caught in IPB survey activities in 2013.

Figure II-186 A Number of Non-Fish Resources Species Identified from IPB Survey Results in 2013



Map II-18 Location of Spawning Grounds in Bintuni Bay

2.2.2.4 Food Webs

The types of organisms as food for fishes in the Bintuni Bay are presented in **Table II-97**. In the table, it is indicated that existing all organisms groups have been consumed by the fish community. In terms of the comprehensive of trophic levels (food webs), fish community in Bintuni Bay is considered comprehensive, that means each trophic level is filled by an existing species. For example, *Moolgarda engeli* is a detritivore fish; *Anodontostoma chacunda* and *Scatophagus argus* is considered as phytoplankton eating fish; *Apogon cyanosoma*, *Ambassis nalua*, and *Encrasicholina heteroloba* are included in the zooplankton eating fish group. The benthivore group is populated by *Pomadasys kaakan* and *P. argyreus*. *Himantura gerrardi, Netuma thalasina,* and *Lobotes surinamensis* is a member of the mollusk eating group; *Setipinna tenuifilis, Sillago sihama,* and *Johnius amblycephalus* are in the crustacivore group; whereas members of the piscivore group among others include *Carcharhinus macloti, Paraplotossus albilabris, and Ulua mentalis*. Therefore, there are no empty trophic niches in the waters of Bintuni Bay.

Based on the food groups presented in **Table II-97** hypothetical food webs of the fish community in the Bintuni Bay as illustrated in **Figure II-187.** The food web complexity reflects the wealth of habitat niches and food that supports the diversity of fish species in the Bintuni Bay.

Table II-97 Food Groups, Trophic Categories, and Types of Fishes Reproduction in the Bintuni Bay

No.	Species	Food Group	Trophic Category	Reproduction Type
1	*Carcharhinus macloti*	Fish, Shrimp	*Piscivore*	*Viviparus*
2	*Carcharhinus sealei*	Fish, Shrimp	*Piscivore*	*Viviparus*
3	*Stegostoma fasciatum*	*Mollusk*	*Molluscivore*	*Oviparus*
4	*Himantura gerrardi*	*Mollusk*	*Molluscivore*	*Oviparus*
5	*Encrasicholina heteroloba*	Zooplankton	*Zooplanktivore*	*Oviparus*
6	*Encrasicholina punctifer*	Zooplankton	*Zooplanktivore*	*Oviparus*
7	*Encrasicolina* sp.	Zooplankton	*Zooplanktivore*	*Oviparus*
8	*Setipinna taty*	*Microcrustacean*	*Crustacivore*	*Oviparus*
9	*Setipinna tenuifilis*	*Microcrustacean*	*Crustacivore*	*Oviparus*
10	*Stolephorus commersonii*	Phyto- & Zooplankton	*Planktivore*	*Oviparus*
11	*Stolephorus indicus*	Phyto- & Zooplankton	*Planktivore*	*Oviparus*
12	*Stolephorus waitei*	Phyto- & Zooplankton	*Planktivore*	*Oviparus*
13	*Thryssa baelama*	*Microcrustacean*	*Crustacivore*	*Oviparus*
14	*Thryssa encrasicholoides*	*Microcrustacean*	*Crustacivore*	*Oviparus*
15	*Thryssa hamiltonii*	*Microcrustacean*	*Crustacivore*	*Oviparus*
16	*Thryssa mystax*	Zooplankton, *Microcrustacean*	*Zooplanktivore*	*Oviparus*
17	*Thryssa setirostris*	Phyto- & Zooplankton	*Planktivore*	*Oviparus*
18	*Pellona ditchela*	*Microcrustacean*	*Crustacivore*	*Oviparus*
19	*Amblygaster sirm*	Phyto- & Zooplankton	*Planktivore*	*Oviparus*
20	*Anodontostoma chacunda*	Phytoplankton	*Phytoplanktivore*	*Oviparus*

No.	Species	Food Group	Trophic Category	Reproduction Type
21	*Escualosa thoracata*	Phyto- & Zooplankton	*Planktivore*	*Oviparus*
22	*Sardinella albella*	Phyto- & Zooplankton	*Planktivore*	*Oviparous*
23	*Arius argyropleuron*	Fish, Shrimp	*Piscivore*	*Oviparous*
24	*Arius armiger*	Fish	*Piscivore*	*Oviparous*
25	*Arius graeffei*	*Mollusc, Fish*	*Molluscivore*	*Oviparous*
26	*Arius leptaspis*	*Mollusc, Fish*	*Molluscivore*	*Oviparous*
27	*Netuma thalassina*	*Mollusc, Shrimp*	*Molluscivore*	*Oviparous*
28	*Paraplotosus albilabris*	Fish, Shrimp	*Piscivore*	*Oviparous*
29	*Plotosus lineatus*	Fish, Shrimp	*Piscivore*	*Oviparous*
30	*Harpadon nehereus*	Fish, Shrimp	*Piscivore*	*Oviparous*
31	*Saurida tumbil*	Fish, Shrimp	*Piscivore*	*Oviparous*
32	*Moolgarda engeli*	*Detritus,* Phytoplankton	*Detritivore*	*Oviparous*
33	*Ambassis nalua*	Zooplankton	*Zooplanktivore*	*Oviparous*
34	*Apogon cyanosoma*	Zooplankton	*Zooplanktivore*	*Oviparous*
35	*Sillago sihama*	Crab, Shrimp	*Crustacivore*	*Oviparous*
36	*Alepes vari*	Fish	*Piscivore*	*Oviparous*
37	*Carangoides chrysophrys*	Fish	*Piscivore*	*Oviparous*
38	*Caranx bucculentus*	Fish, Shrimp	*Piscivore*	*Oviparous*
39	*Caranx ignobilis*	Fish, Shrimp	*Piscivore*	*Oviparous*
40	*Decapterus kurroides*	Fish, Shrimp	*Piscivore*	*Oviparous*
41	*Megalaspis cordyla*	Fish, Shrimp	*Piscivore*	*Oviparous*
42	*Parastromateus niger*	Fish, Mollusc	*Piscivore*	*Oviparous*
43	*Scomberoides tol*	Fish	*Piscivore*	*Oviparous*
44	*Selaroides leptolepis*	Zooplankton	*Zooplanktivore*	*Oviparous*
45	*Ulua mentalis*	Fish, Shrimp	*Piscivore*	*Oviparous*
46	*Eubleekeria splendens*	Zooplankton, *Microcrustacean*	*Zooplanktivore*	*Oviparous*
47	*Photopectoralis bindus*	*Microcrustacean*	*Crustacivore*	*Oviparous*
48	*Leiognathus decorus*	*Microcrustacean*	*Crustacivore*	*Oviparous*
49	*Leiognathus equulus*	*Microcrustacean*	*Crustacivore*	*Oviparous*
50	*Secutor ruconius*	*Microcrustacean*	*Crustacivore*	*Oviparous*
51	*Lutjanus argentimaculatus*	Fish, Shrimp	*Piscivore*	*Oviparous*
52	*Lobotes surinamensis*	*Mollusc, Fish*	*Molluscivore*	*Oviparous*
53	*Pomadasys argyreus*	*Macrozoobenthos*, fish	*Benthivore*	*Oviparous*
54	*Pomadasys kaakan*	*Macrozoobenthos*, fish	*Benthivore*	*Oviparous*
55	*Eleutheronema tetradactylum*	Shrimp, Fish	*Crustacivore*	*Oviparous*
56	*Johnius amblycephalus*	Shrimp	*Crustacivore*	*Oviparous*
57	*Johnius australis*	Shrimp	*Crustacivore*	*Oviparous*
58	*Johnius belangerii*	Shrimp	*Crustacivore*	*Oviparous*
59	*Johnius* sp.	Shrimp	*Crustacivore*	*Oviparous*
60	*Nibea soldado*	Shrimp, Fish	*Crustacivore*	*Oviparous*
61	*Protonibea diacantha*	Shrimp, Fish	*Crustacivore*	*Oviparous*
62	*Upeneus moluccensis*	*Mollusc, Polychaeta*	*Molluscivore*	*Oviparous*

No.	Species	Food Group	Trophic Category	Reproduction Type
63	*Upeneus sulphureus*	*Mollusc, Polychaeta*	*Molluscivore*	*Oviparous*
64	*Drepane longimana*	*Crustacean, Polychaeta*	*Crustacivore*	*Oviparous*
65	*Drepane punctata*	*Crustacean, Polychaeta*	*Crustacivore*	*Oviparous*
66	*Terapon theraps*	*Crustacean, Polychaeta*	*Crustacivore*	*Oviparous*
67	*Brachyamblyopus coecus*	*Polychaeta, Bivalvia*	*Benthivore*	*Oviparous*
68	*Kurtus gulliveri*	*Microcrustacean*	*Crustacivore*	*Oviparous*
69	*Scatophagus argus*	Phytoplankton	*Phytoplanktivore*	*Oviparous*
70	*Lepturacanthus savala*	*Crustacean, Fish*	*Crustacivore*	*Oviparous*
71	*Scomberomorus commerson*	Fish	*Piscivore*	*Oviparous*
72	*Sphyraena barracuda*	Fish	*Piscivore*	*Oviparous*
73	*Psenopsis humerosa*	*Mollusc, Polychaeta*	*Molluscivore*	*Oviparous*
74	*Aseraggodes klunzingeri*	*Crustacean, Mollusc*	*Crustacivore*	*Oviparous*
75	*Zebrias zebra*	*Mollusc*	*Molluscivore*	*Oviparous*
76	*Cynoglossus cynoglossus*	*Crustacean, Mollusc, Polychaeta*	*Crustacivore*	*Oviparous*
77	*Cynoglossus lingua*	*Crustacean, Mollusc, Polychaeta*	*Crustacivore*	*Oviparous*
78	*Cynoglossus puncticeps*	*Crustacean, Mollusc, Polychaeta*	*Crustacivore*	*Oviparous*
79	*Paraplagusia bilineata*	*Crustacean, Mollusc, Polychaeta*	*Crustacivore*	*Oviparous*
80	*Triacanthus* sp.	*Mollusc, Polychaeta*	*Molluscivore*	*Oviparous*
81	*Tripodichthys blochii*	*Crustacean, Polychaeta*	*Crustacivore*	*Oviparous*
82	*Lagocephalus inermis*	*Crustacean, Mollusc*	*Crustacivore*	*Oviparous*

Source: IPB, 2013

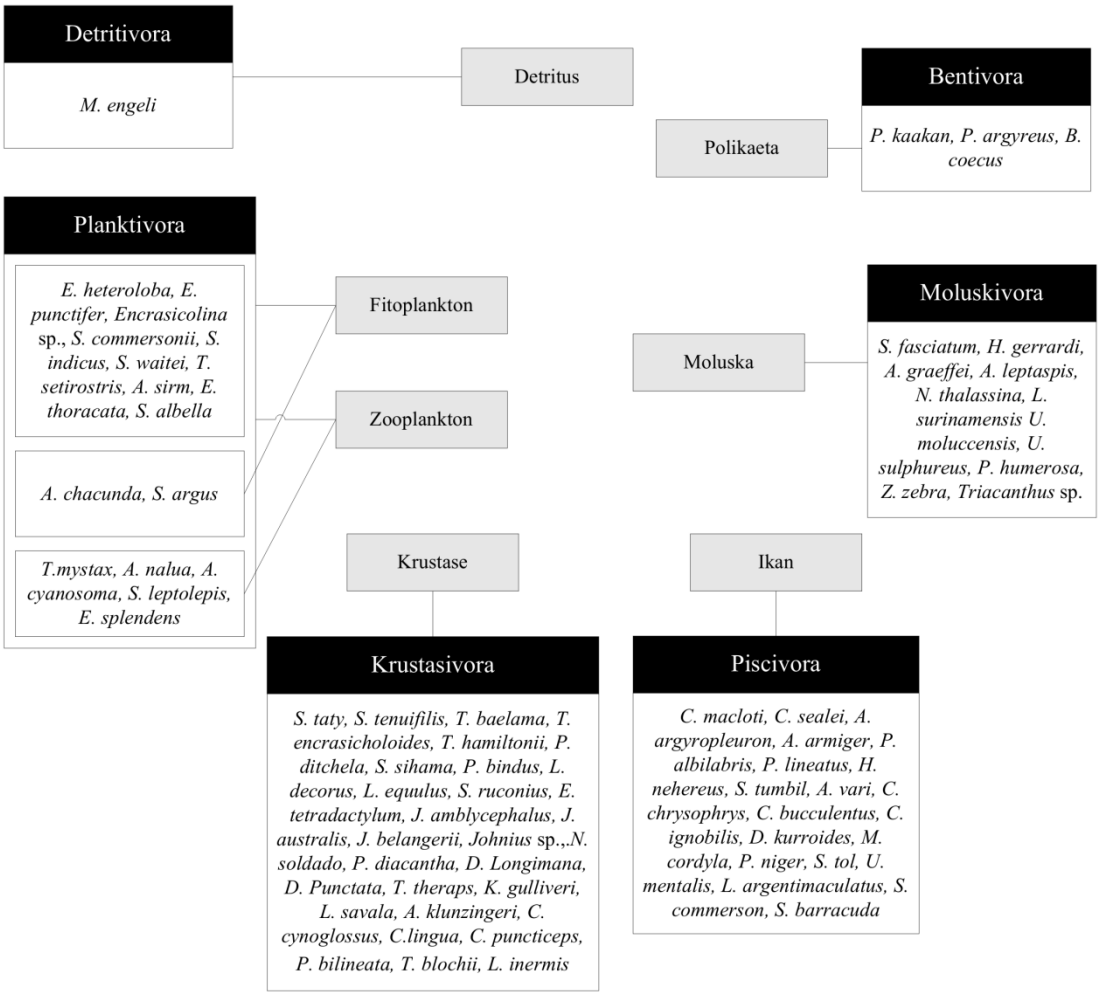


Figure II-187 Hypothetical Food Web of the Fish Community in the Bintuni Bay (IPB, 2013)

2.2.2.5 Bioecology

Based on the Fisheries Survey Report conducted in June and December 2007 (**Table II-98),** Simanjuntak *et al*. (2011) added the bioecology category of each species identified in the Bintuni Bay.

Table II-98 List of Fish Species Name Based on the Bioecology Category in the Bintuni Bay

No	Ordo	Family	Species	Common Name	KBE
1	*Anguilliformes*	*Anguillidae*	*Anguilla marmorata*		Co
		Chlopsidae	*Boehlkenchelys longidentata*		Mo
		Muraenesocidae	*Muraenesox bagio*		ME
2	*Aulopiformes*	*Synodonthidae*	*Harpodon nehereus*	*Bombay-duck*	ME
			Harpodon translucens		ME
			Saurida argentea		ME
			Saurida tumbil		ME

No	Ordo	Family	Species	Common Name	KBE
3	*Beloniformes*	*Belonidae*	*Strongylura strongylura*	*Spottail needlefish*	ME
		Hemirhamphidae	*Hyporhamphus neglectissimus*	*Black-tipped garfish*	ME
4	*Carcharniformes*	*Hemigaleidae*	*Hemigaleus microstoma*		Ma
5	*Clupeiformes*	*Clupeidae*	*Anadontostoma chacunda*	*Chacunda gizzard shad*	ME
			Anadontostoma selangkat		ME
			Escualosa thoracata	*White sardine*	ME
			Herklotsichthys quadrimaculatus	*Bluestripe herring*	ME
		Engraulididae	*Encrasicholina heteroloba*	*Shorthead anchovy*	Ma
			Encrasicholina devisi		Ma
			Setipinna melanochir	*Dusky-hairfin anchovy*	ME
			Setipinna tenuifils	*Common hairfin anchovy*	Ma
			Stolephorus andhraensis	*Andhra anchovy*	Mo
			Stolephorus commersonii	*Commerson's anchovy*	ME
			Stolephorus waitei		ME
			Thryssa baelama	*Baelama anchovy*	ME
			Thryssa cf. vtrirostris	*Orangemouth anvhovy*	ME
			Thryssa setirostris	*Longjaw thryssa*	ME
			Thryssa hamiltonii	*Hamilton's thryssa*	ME
		Pristigasteridae	*Pellona ditchela*		ME
6	*Gasterosteiformes*	*Syngnathidae*	*Trachyrhamphus bicoarctatus*		ME
7	*Mugiliformes*	*Mugilidae*	*Liza subviridis*		Em
			Valamugil engeli		Em
			Mugil cephalus		ME
8	*Percoformes*	*Ambassidae*	*Ambassis interrupta*	*Long-spined glass perchlet*	Es
			Ambassis nalua	*Scalloped perchlet*	Es
			Ambassis buruensis	*Buru glass perchlet*	Es
		Carangidae	*Carangoides malabaricus*	*Malabar trevally*	Mo
			Caranx para	*Razorbelly scad*	Mo
		Centropomidae	*Psammoperca vaigiensis*		ME
		Drepanidae	*Drepane punctata*	*Spotted sicklefish*	ME
		Eleotridae	*Ophiocara porocephala*		Ec
			Butis amboinensis		Ec
			Butis butis		Ec
8	*Percoformes*	*Gobiidae*	*Oxuderces dentatus*		Es
			Periophthalmus novemradiatus	*Pearse's mudskipper*	Es
			Pseudogobiopsis sp.		Es
		Haemulidae	*Pomadasys kaakan*	*Javelin grunter*	Em
			Pomadasys argenteus		Em
		Kraemeriidae	*Kraemeria* sp.		Es
		Kurtidae	*Kurtus gulliveri*	*Nurseryfish*	Es
		Leiognathidae	*Leiognathus splendens*	*Splendid ponyfish*	ME
			Secutor megalolepis		ME

No	Ordo	Family	Species	Common Name	KBE
			Secutor ruconius	*Deep pugnose ponyfish*	ME
			Leiognathus bindus		ME
			Leiognathus equulus		ME
		Lethrinidae	*Lethrinus harak*	*Thumbprint emperor*	ME
		Lutjanidae	*Lutjanus johnii*		ME
			Lutjanus fuscescens		Ec
			Lutjanus lemniscatus		Mo
		Monodactylidae	*Monodactylus argenteus*		Es
		Mullidae	*Mulloidichthys flavolineatus*	*Yellostripe goatfish*	ME
			Mulloidichthys vanicolensis		ME
		Polynemidae	*Euletheronema tetradactylum*	*Fourfinger threadfin*	Em
		Scatophagidae	*Scatophagus argus*		Es
		Sciaenidae	*Atrobuca (Nibea) nibe*	*Longfin kob*	Mo
			Johnieops sina	*Sin croaker*	Es
			Johnius borneensis	*Sharpnose hammer croaker*	ME
			Johnius (Johnius) australis	*Bottlenose jewfish*	ME
			Johnius (Johnius) macropterus	*Largefin croaker*	ME
			Johnius (Johnius) amblycephalus	*Bearded croaker*	ME
			Johnius (Johnius) belangerii	*Belanger's croaker*	ME
			Nibea soldado	*Soldier croaker*	ME
			Otolithoides biauritus	*Bronze croaker*	ME
			Otolithes ruber		ME
		Siganidae	*Siganus canaliculatus*	*White-spotted spinefoot*	Mo
		Sillaginidae	*Sillago sihama*	*Silver sillago*	Em
		Sparidae	*Acathopagrus berda*		Em
		Teraponidae	*Terapon theraps*	*Largescaled therapon*	ME
			Terapon puta		ME
		Toxotidae	*Toxotes jaculatrix*		ME
		Trichiuridae	*Lepturacanthus savala*	*Savalani hairtail*	ME
			Trichiurus lepturus	*Largehead hairtail*	ME
		Cepolidae	*Acathocepola limbata*		ME
		Scombridae	*Rastrelliger brachysoma*		Mo
			Scomberomorus commerson		Mo
9	*Pleuronectiformes*	*Paralichthyidae*	*Pseudorhombus arsius*	*Largetooth flounder*	ME
		Cynoglossidae	*Paraplagusia bilineata*	*Doublelined tonguesole*	Es
			Cynoglossus bilineatus	*Fourlined tonguesole*	ME
			Cynoglossus punticeps	*Speckled tonguesole*	ME
		Soleidae	*Aseraggodes klunzingeri*	*Tailed tonguesole*	ME
10	*Scorpaeniformes*	*Platycephalidae*	*Cociela punctata*		ME
		Scorpaenidae	*Centropogon australis*		Es

No	Ordo	Family	Species	Common Name	KBE
11	*Siluriformes*	*Ariidae*	*Arius (Cochlefelis) danielsi*	*Daniel's catfish*	ME
			Arius (Nemapteryx) armiger	*Threadfin catfish*	ME
			Arius (Cinetodus) carinatus	*Comb-spined catfish*	ME
			Arius (Neoarius) graeffei	*Lesser salmon catfish*	ME
			Plicofollis argyropleuron		ME
			Arius leptaspis		ME
		Plotosidae	*Paraplotosus albilabris*	*Whitelipped eel catfish*	ME
			Plotosus lineatus		ME
12	*Tetraodontiformes*	*Tetraodontidae*	*Chelonodon patoca*	*Milkspotted puffer*	ME
			Lagocephalus lunaris	*Green rough-backed puffer*	ME
			Arothron reticularis	*Reticulated pufferfish*	ME
			Tetraodon erythrotaenia	*Red-striped toadfish*	ME
			Tetractenos glaber		ME
			Lagocephalus inermis		ME
			Lagocephalus sceleratus		ME
		Triacanthidae	*Trixiphichthys weber*	*Blacktip tripodfish*	ME

Remarks :
KBE (Bio-Ecological Category): **Co**: *continental species, occasional in estuaries*; **Ec**: *estuarine species from continental origin*; **Es**: *strictly estuarine species*; **Em**: *estuarine species from marine origin*; **ME**: *marine-estuarine species*; **Ma**: *marine species accessory in estuaries*; **Mo**: *marine species occasional in estuaries* (Modification by Albareth *et al*., 2004).

Based on **Table II-98,** the number of fish species recorded in the 2007 survey was 106 species, as part of 46 families and 12 ordos. The *Perciformes* ordo had the most species with 53 species or more than 50% of the total species, followed by *Clupeiformes* with 16 species (15.1%) and *Siluriformes* as well as *Tetraodontiformes* with eight species each (7.55%).

Based on the habitat characteristics and distribution patterns, Simanjuntak *et al*. (2011) categorized these fishes into several bioecological categories (**Figure II-188 and Figure II-189).** In general, the fishes found are native species of the sea (ME > 60%). There are some fish come from inland waters, but are able to adapt to the estuarine environment, or vice versa. Marbled Eel (*Anguilla marmorata*) are fish that utilize two types of habitats to complete their life cycle, starting from deep ocean waters, estuaries, then freshwaters. The diversity of fish, habitat and distribution patterns are an overview of the ecological integrity and ecological connectivity between various types of waters habitats in the Bintuni Bay and the surroundings.

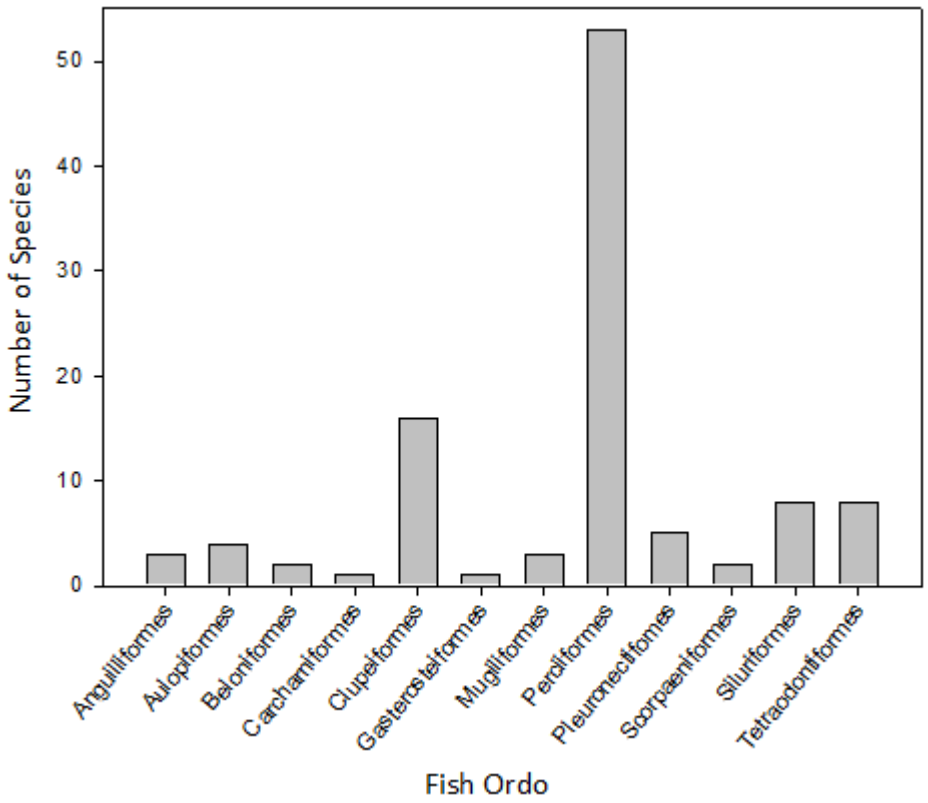


Figure II-188 **Grouping of Fishes Found in the Study Area Based on Ordo (Data: *Fisheries Survey*, 2007)**

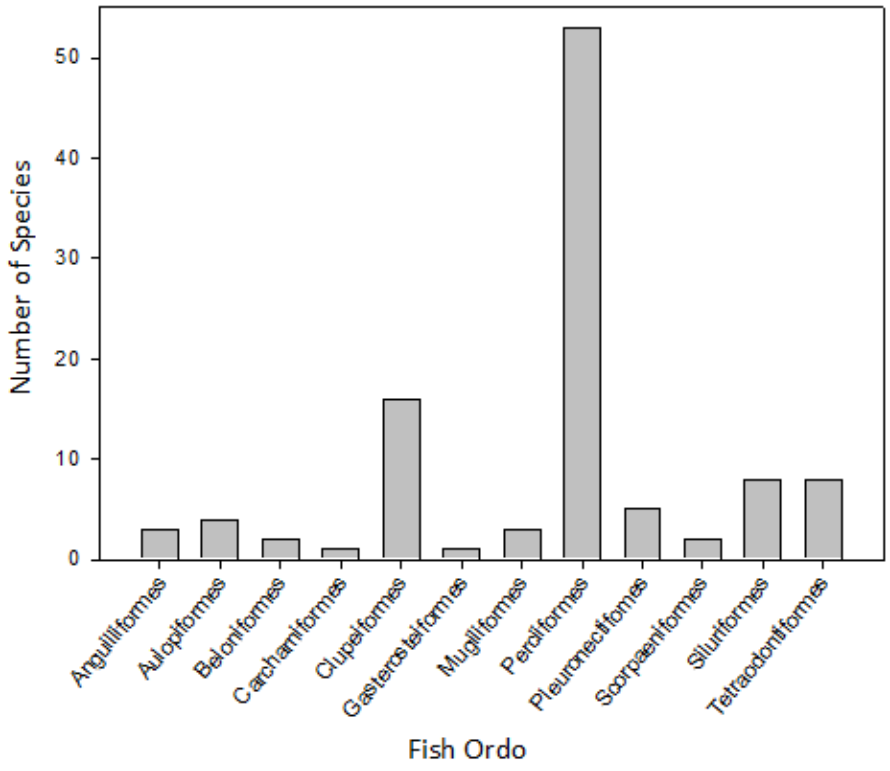


Figure II-189 **Bio-Ecological Category of Fish Species Recorded in the Study Area**

2.2.2.6 Marine Mammals and Reptiles

Data Source

Data and information regarding marine mammals and reptiles were derived from primary and secondary data. Primary data was obtained from survey activities conducted from April 30th –May 8th, 2013 in conjunction with fisheries survey activities. Secondary data was mainly obtained from:

1. The Report of Bintuni-Berau Bay Rapid Ecological Assessment (REA): Marine Mammals and Marine Reptiles (Kahn *et al*., 2006) then was summarized in dual language as Guide Book on Marine Mammals and Sea Turtles in Berau and Bintuni *Bay* (Tangguh LNG Document);
2. The observation on marine mammals and reptiles during the 2D and 3D seismic survey activities in Berau/Bintuni Bay that was conducted between 2008 and 2011. The comprehensive report on the results of marine mammals and reptiles monitoring in this seismic activity is summarized in the UKL-UPL implementation report of these activities;
3. The observation on marine mammals and reptiles during TEAP (Tangguh Exploration and Appraisal Project) Exploration drilling was conducted since March-May 2013; and
4. The routine observation report on ships and platforms operating in the Tangguh LNG

Previous Observation and Research Data

Based on the visual observation conducted in September-November 2006 in the Study of Bintuni-Berau Bay Rapid Ecological Assessment *(REA):* Marine Mammals and Marine Reptiles, four dolphin and one whale species were discovered inhabiting the Bintuni Bay waters, which are:

1. *Balaenoptera brydei* (Bryde's Whale);
2. *Sousa chinensis* (Indo-Pacific *humpback dolphin*);
3. *Stenella longirostris* (Spinner Dolphin);
4. *Tursiops aduncus* (Indo-Pacific bottlenose dolphin); and
5. *Tursiops truncatus* (Common Bottlenose Dolphin).

In this report, visual observation was conducted on several areas predicted to represent the overall Berau/Bintuni Bay area. The observation was also conducted with the passive acoustic method using a Hydrophone capturing 12 locations covering two bay regions. Four points were in Bintuni Bay, seven points were in Berau Bay and one point in the outermost area of the waters (**Figure II-190).**

The study was conducted for 15 days with the total observation duration at approximately 79 hours and the tracking distance as far as 1,296 sea miles in all types of habitats. There was a total of 62 sightings and a total of 364 individuals were counted.

Figure II-190 Trajectory of the Visual and Acoustic Survey Conducted in the Bintuni Bay and Berau Bay to Identify the Existence and Distribution Patterns of Marine Mammals in this Region (Kahn *et al.*, 2006)

Based on the frequency of sightings and species found, the Chinese white dolphin/*Sousa chinensis* was the most common species found (> 75% sightings), while the most rare was the Bryde Whale/*Balaenoptera brydei* ((<5% or only one sighting). There were two other dolphin species with similar sighting percentages, Spinner Dolpin/*Stenella longirostris* and Indo-Pacific Bottlenose dolphin/*Tursiops aduncus* at 10 – 14%. Common Bottlenose Dolpin/*Tursiops truncatus* was the most rare dolphin species found (<5%).

Consistent with the existing percentage, the *Sousa chinensis* dolphin had the highest abundance compare to others. The results of the observation and records on marine mammal sightings are spatially mapped in the center, eastern, and western (**Figure II-191).**

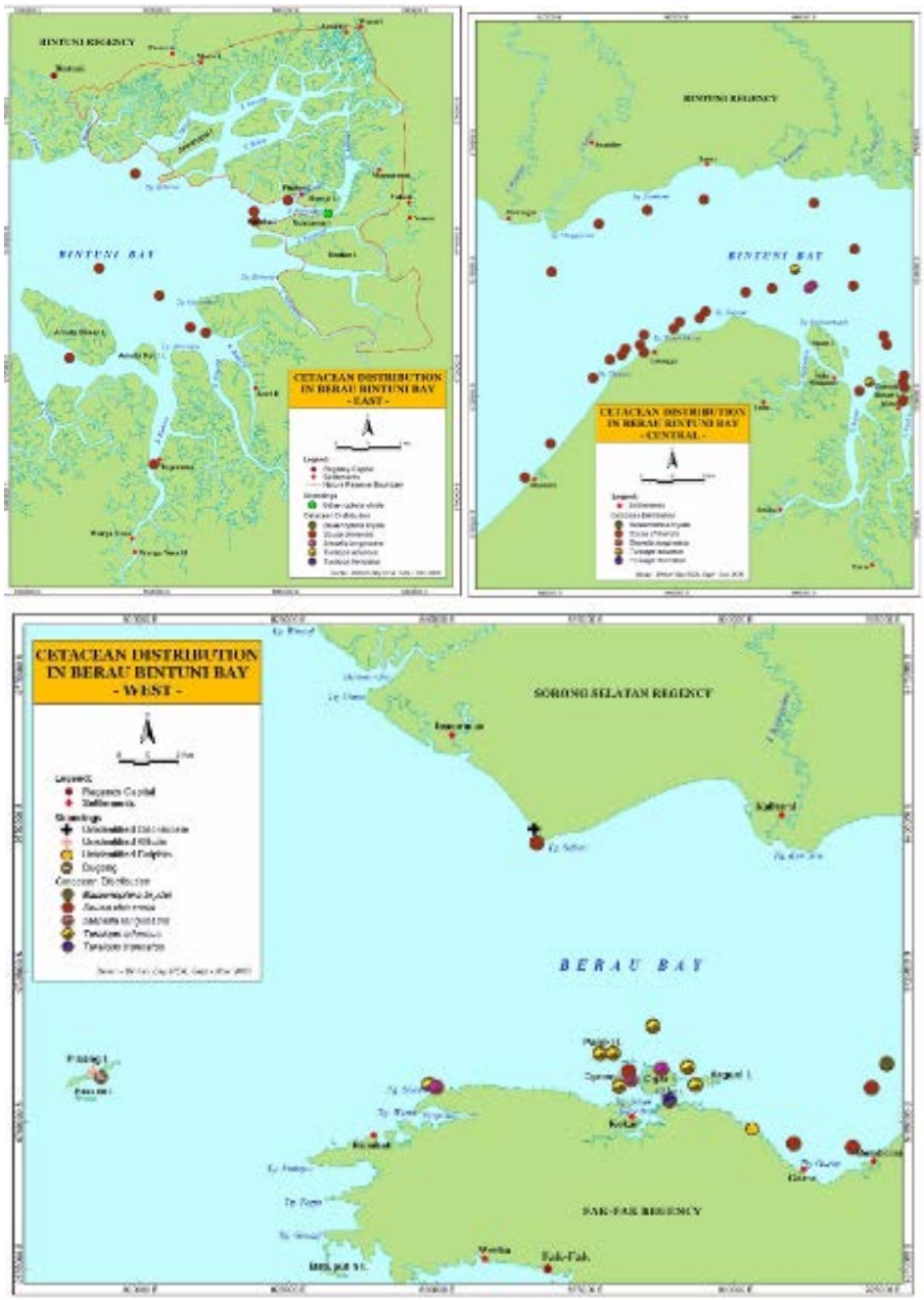


Figure II-191 Map of Marine Mammal Sightings in the Bintuni Bay and Berau Bay, Covering the Center, East (Top), and West (Bottom) (Kahn *et al.*, 2006)

Apart from data on marine mammal species observed in the Bintuni Bay, information regarding marine reptiles particularly turtles was also obtained from this survey activity. The methods of observation conducted on turtles are the followings:

- In-water direct observation survey, in determined areas;
- Flotsam Survey, which is by observing the debris/remnants of objects or trees carried into the sea;

- Turtle head count/direct visual observation;
- Observation on the nesting area; and
- Community Interview

Based on the results of the visual observation and in-water survey, it was identified that there were at least two turtle species in the waters of Berau/Bintuni Bay, which are the Green Turtle (*Chelonia mydas*) and Hawskbill Turtle (*Eretmochelys imbricata*), whereas data that was obtained from community interviews indicated that there were other turtle species in the waters of Berau/Bintuni Bay covering the Leatherback Turtle (*Dermochelys coreacea*) and (Olive Ridley Turtle (*Lepidochelys olivacea*).

Apart from the observation on turtle species, observation was also conducted on nesting areas for turtles around the waters in the Berau/Bintuni Bay, where it was discovered that the sandy beaches of Ogar island and Pisang Island in the western of the bay are nesting areas, particularly for Green Turtle and Hawksbill Turtle.

Observation on Marine Mammals and Reptiles in the Tangguh Seismic Program (2008-2011)

In the period between 2008 – 2011, the Tangguh LNG conducted 3 seismic survey programs in the Berau/Bintuni Bay area, which were:

1. 3D ILX seismic survey activities from December 2008 – August 2009;
2. 3D *appraisal* seismic survey activities from December 2009 - June 2010; and
3. 3D WDR seismic survey activities from September 2010 – March 2011.

The locations of the seismic survey area are illustrated in **Figure II-192.**

During these activities, the Tangguh LNG conducted a monitoring program on marine mammals and reptiles as one of the best practices in the effort to minimize the potential disruption of seismic activities to marine mammals and reptiles. The results of the observation indicated that the existence of several marine mammals and reptiles have been identified and were suspected to be in the waters of Berau/Bintuni Bay from the previous study (ref. REA, 2006).

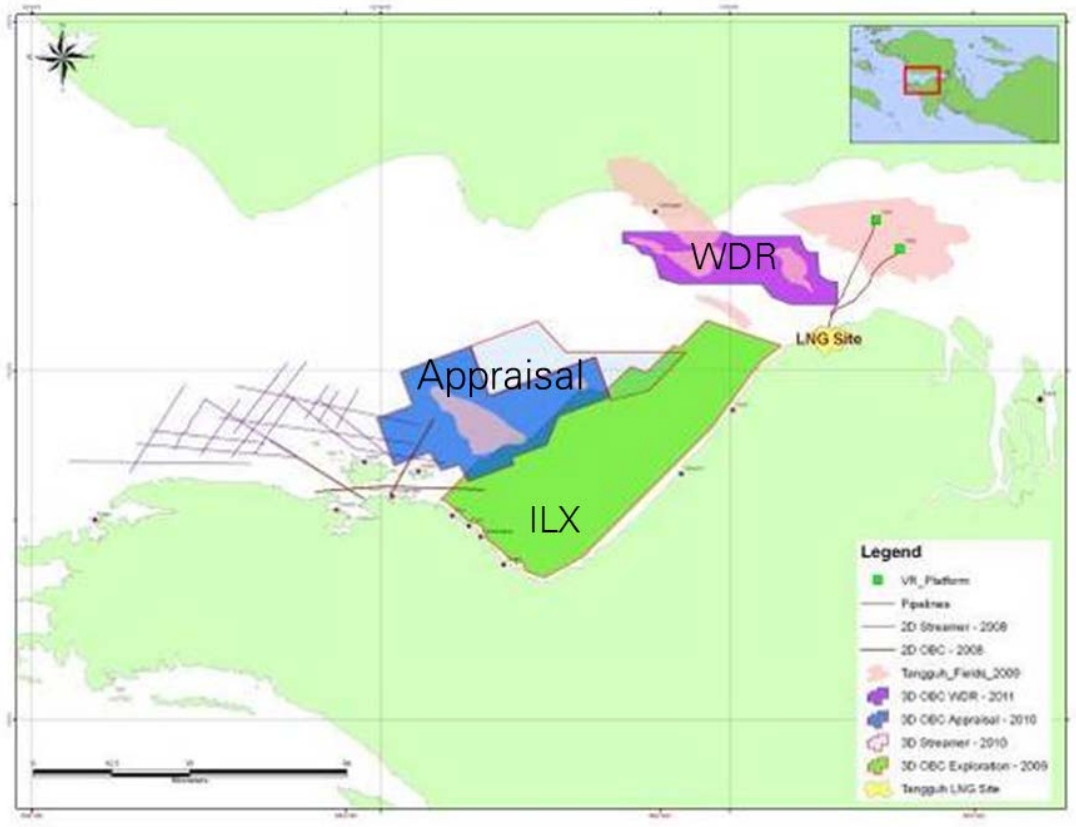


Figure II-192 Locations of Seismic Survey Activities in the Berau/Bintuni Bay from 2008-2011

The observation on the three seismic activities recorded 116 sightings of marine mammals and reptiles (**Figure II-193**). The results are considered to strengthen the data on animal species distribution in the center up to the western of the bay. Some marine mammal and marine reptile species identified during this monitoring are:

1. Indo-Pacific Bottlenose Dolphin(*Tursiops aduncus*);
2. Indo-Pacific Humpback Dolphin(*Sousa chinensis*);
3. Spinner Dolphin (*Stenella longirostris*);
4. Common Bottlenose Dolphin (*Tursiops truncatus*);
5. Green Turtle (*Chelonia mydas*);
6. Hawksbill Turtle (*Eretmochelys imbricata*);
7. Leatherback turtle *Dermochelys coreacea*); and
8. Olive Ridley Turtle (*Lepidochelys olivacea*).

The above data has strengthened and conformed the outcome of the community interviews in *Bintuni-Berau Bay Rapid Ecological Assessment (REA*) study regarding

the existence of the Leatherback Turtle and Olive Ridley Turtle in the waters of the Berau/Bintuni Bay.

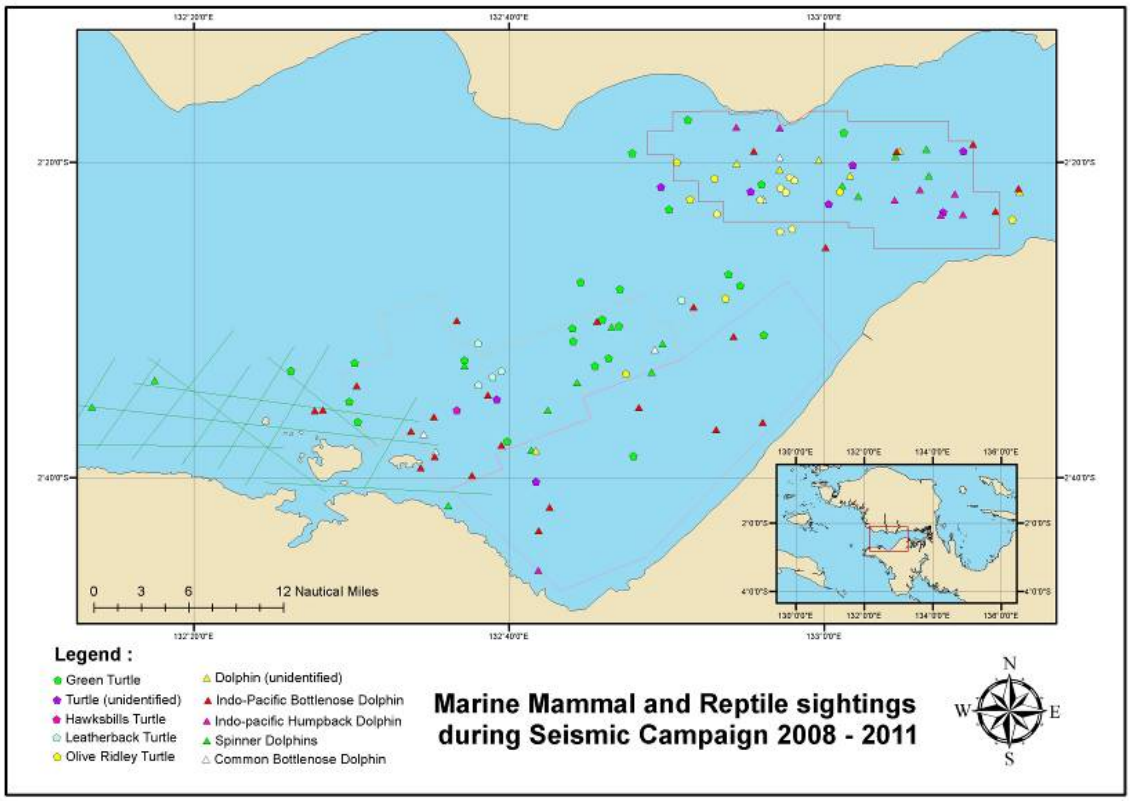


Figure II-193 Marine Mammal and Reptile Sightings Points during Seismic Activities

Marine Mammals and Reptiles Observation on Ships and Platforms Operating within the Tangguh LNG Area

The marine mammal and reptile observation program carried out by the Tangguh LNG on supporting vessels and LNG platforms has been assessed as quite helpful in providing information regarding the existence of marine mammals and reptiles in the Bintuni Bay waters, particularly in the operational area of the Tangguh LNG.

The data obtained from January to April 2012 recorded 44 marine mammals sighting and four turtles sighting. Llimited knowledge of observers, in this case were the vessel crews, has led to the data with incomplete information on the species of observed mammals and turtles. The sighting locations with marine mammals and turtles can be viewed in **Figure II-194.**

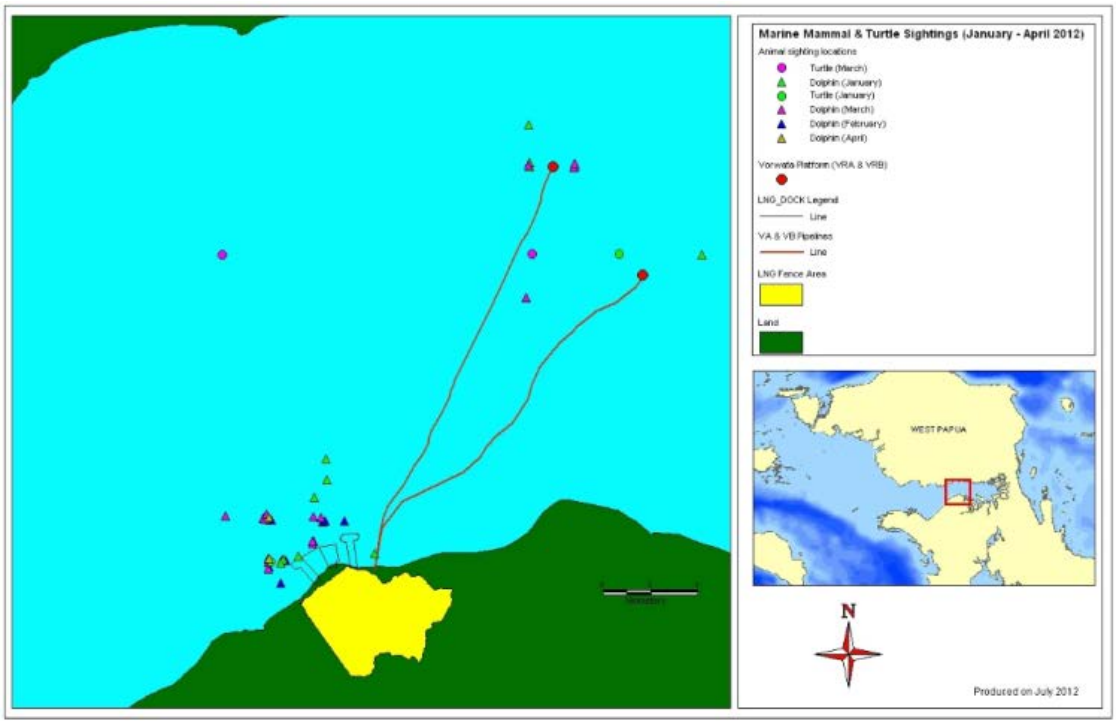


Figure II-194 Distribution of Marine Mammal and Reptile Sightings as the Observation Results of the Tangguh LNG's Vessels and Platforms (January-April 2012)

Observation on Marine Mammals and Reptiles During TEAP Drilling Activities

The same observation efforts on marine mammals and reptiles were made during TEAP (Tangguh Exploration and Appraisal Project) drilling activities that began since February 2013. The drilling activities are carried out in the eastern of the bay so the data obtained from this observation are expected to strengthen the information regarding the existence and species of marine mammals and reptiles spread across the eastern of Bintuni Bay. (**Figure II-195).**

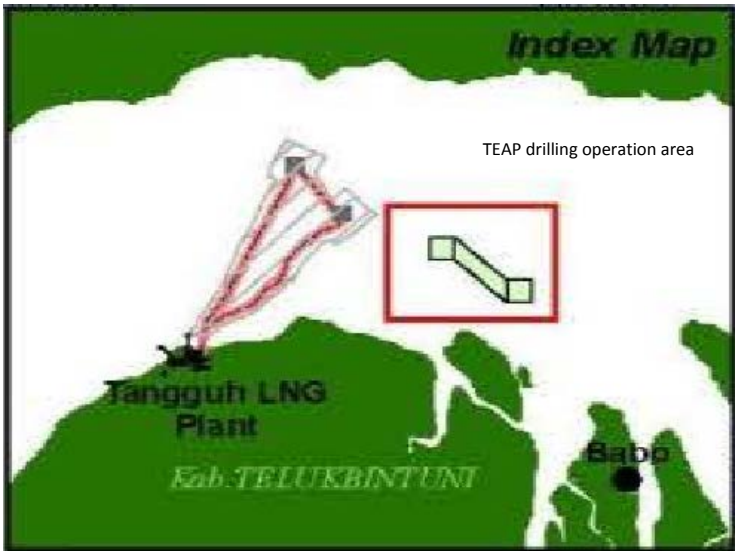


Figure II-195 TEAP Drilling Operation Area

The observation data was collected from February to June 2013 indicated that there were 105 marine mammals and reptiles sightings with the following composition:

Marine Mammals:

1. Seven sightings of Indo-pacific humpback dolphin (*Sousa chinensis*);
2. Six sightings of Spinner Dolphins (*Stenella longirostris*);
3. One sighting of the Brdye Whale (*Balaenoptera bydae*); and
4. Seventy dolphin appearances which its species has not been or unable to be identified

Marine Reptiles:

1. Four sightings of Green turtle (*Chelonia mydas*);
2. Two sightings of Hawksbill turtle (*Eretmochelys imbricata*);
3. Two sightings of Olive ridley turtle (*Lepidochelys olivacea*);
4. One sighting of a Saltwater Crocodile;
5. One sighting of a marine snake; and
6. Twelve sightings of turtles which its species has not or unable to be identified.

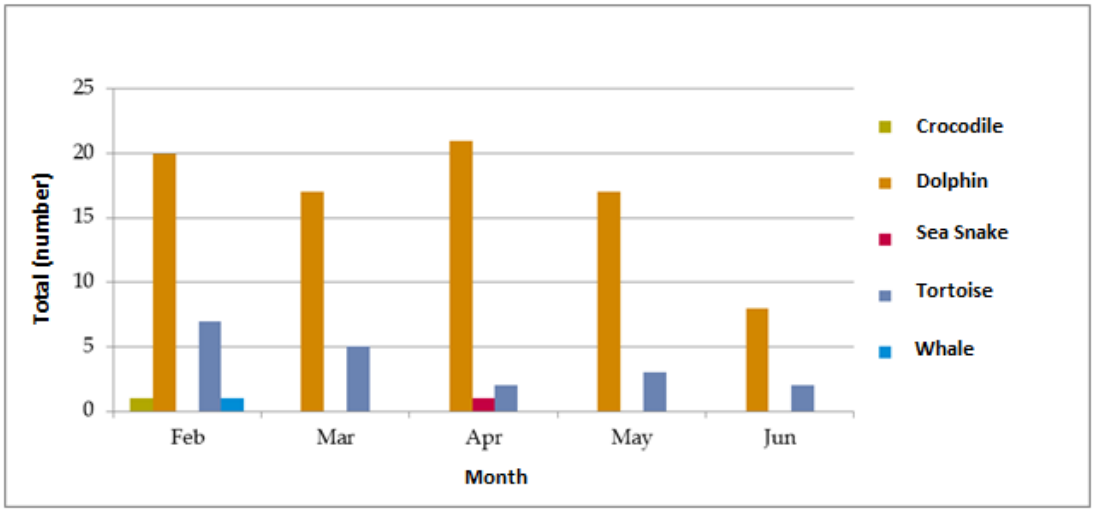


Figure II-196 Total Appearances of Marine Mammals and Reptiles during TEAP Drilling Observation (February-June 2013) (Source: BP Wells Environmental Team)

Results of the Survey on Marine Mammals and Reptiles in April-May 2013

Primary data collection was conducted by carrying out a survey using the transect method with the same trajectory as the one in the fisheries survey as illustrated in **Figure II-196.** The observation was conducted using two methods, which were:

1. Observation on water with visual observation (head counts)
   a. Recording the position of appearances with GPS;
   b. Recording the bearing angle of the front, center, and back of marine mammal groups using a magnetic compass;
   c. Recording photos using a 300mm lens camera, particularly for the purpose of identifying visible animals;
   d. Recording the name of the area where the marine mammal and reptile species were seen;
   e. Calculating the number of individuals appearing at the surface;
   f. Position of mammals observed, then determined by the triangulation method.

2. Underwater observation using a hydrophone

   Hydrophones are used to record sounds in the water. During recording, the vessel's engine was shut off and the vessel was put into drifting position and unanchored (speed of the vessel was nil against the movement of water mass). Through sound recording, a number of sounds were obtained to be used to differentiate the mammal species (if there is more than one species in an area); differentiate mammal activities (barking, calling, echo locating, homing and mating). The observation using this hydrophone was conducted in eight observation points in accordance with the gillnet stocking locations in the fisheries survey.

3. Community Interview

   Based on marine mammal observation result during the survey conducted from April 30th –May 8th, 2013, there were 16 marine mammals sightings with the number of individuals spotted > 56 individuals. The range of the meeting time started at 06:51 WIT until 14:32 WIT. Details of visual contact data are found in **Table II-99** and **Figure II-197.** In this survey, the marine mammal species recorded are as follows:

   - Indopacific Bottlenose Dolphin (*Tursiops sp.*);
   - Spinner Dolphin (*Stenella sp.*); and
   - Indo-pacific Humpback Dolphin (*Sousa sp.*)

Table II-99 Visual Contact Data with Mammals in the Bintuni Bay

No	Date	Time	East Longitude	South Latitude	Start	End	Contact Duration	Observed
1	01 May 2013	14:32:04	132° 44' 16.8"	-2° 19' 57.4"	14:32:04		00:09:37	Two Humpback dolphins (*Sousa chinensis*)
	01 May 2013	14:41:41	132° 44' 45.5"	-2° 20' 43.6"		14:41:41		
2	01 May 2013	14:47:28	132° 45' 2.3"	-2° 21' 12.8"	14:47:28		00:04:05	Suspicion of Whales because water blow was observed Or a group of Humpback dolphins (*Sousa chinensis*)
	01 May 2013	14:51:33	132° 45' 14.6"	-2° 21' 32.7"		14:51:33		
3	01 May 2013	16:50:37	133° 5' 34.3"	-2° 22' 40.3"	16:50:37		00:00:30	One *Stenella* and one *calve*
	01 May 2013	16:51:07	133° 5' 34.3"	-2° 22' 40.3"		16:51:07		
4	02 May 2013	10:25:10	133° 5' 34.3"	-2° 22' 40.3"	10:25:10		00:00:30	One *Stenella*
	02 May 2013	10:25:40	133° 5' 38.5"	-2° 22' 40.5"		10:25:40		
5	02 May 2013	11:02:01	133° 10' 24.7"	-2° 22' 29.7"	11:02:01		00:00:37	Humpback dolphin (*Sousa chinensis*)
	02 May 2013	11:02:38	133° 10' 29.1"	-2° 22' 30.4"		11:02:38		
6	04 May 2013	07:39:18	133° 14' 19.1"	-2° 22' 31.9"	07:39:18		00:02:48	One *Stenella*; or Bottlenose
	04 May 2013	07:42:06	133° 14' 30.3"	-2° 22' 34.6"		07:42:06		
7	04 May 2013	07:44:14	133° 14' 39.3"	-2° 22' 38.8"	07:44:14		00:18:51	Four *Stenella Bow riding*
	04 May 2013	07:44:24	133° 14' 41.7"	-2° 22' 39.9"		07:44:24		
8	04 May 2013	08:02:32	133° 16' 0.5"	-2° 23' 10.0"	08:02:32		00:00:33	One *Humpback dolphin* (*Sousa chinensis*) and *calve*
	04 May 2013	08:03:05	133° 16' 3.0"	-2° 23' 11.1"		08:03:05		
9	04 May 2013	08:08:20	133° 16' 27.6"	-2° 23' 19.2"	08:08:20		00:00:35	One Humpback dolphin (*Sousa chinensis*) and one *calve*
	04 May 2013	08:08:55	133° 16' 30.5"	-2° 23' 19.8"		08:08:55		
10	04 May 2013	08:45:00	133° 18' 29.6"	-2° 19' 27.4"	08:45:00		00:20:00	One *Stenella*; one bottlenose
	04 May 2013	09:05:00	133° 18' 29.6"	-2° 19' 27.4"		09:05:00		
11	04 May 2013	09:05:04	133° 18' 21.8"	-2° 20' 3.3"	09:05:04		00:07:54	Three groups of bottlenoses, each with 7-8
	04 May 2013	09:12:58	133° 18' 30.7"	-2° 19' 24.6"		09:12:58		
12	04 May 2013	09:27:09	133° 18' 47.3"	-2° 18' 16.6"	09:27:09		00:02:34	Three bottlenoses
	04 May 2013	09:29:43	133° 18' 49.9"	-2° 18' 4.8"		09:29:43		

No	Date	Time	East Longitude	South Latitude	Start	End	Contact Duration	Observed
13	04 May 2013	09:55:00	133° 19' 23.8"	-2° 15' 39.1"	09:55:00		00:00:30	Two-three *Sousa*
	04 May 2013	09:55:30	133° 19' 23.9"	-2° 15' 39.1"		09:55:30		
14	04 May 2013	10:55:00	133° 22' 8.8"	-2° 14' 30.4"	10:55:00		00:00:30	One *sousa* jumping
	04 May 2013	10:55:30	133° 22' 8.8"	-2° 14' 30.4"		10:55:30		
15	06 May 2013	06:51:08	133° 22' 48.8"	-2° 16' 12.3"	06:51:08		00:05:23	Three bottlenose dolphines, one *Stenella*
	06 May 2013	06:56:31	133° 22' 55.2"	-2° 16' 25.6"		06:56:31		
16	06 May 2013	14:06:03	133° 13' 21.8"	-2° 22' 25.8"	14:06:03		00:00:33	Two bottlenose dolphins, *bow riding*
	06 Mei 2013	14:06:36	133° 13' 18.5"	-2° 22' 25.5"		14:06:36		

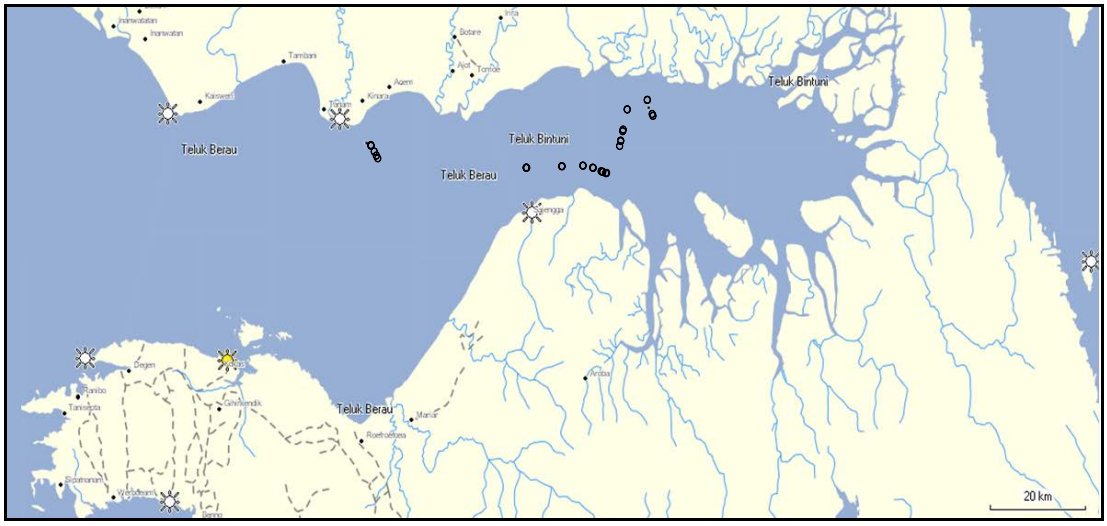


Figure II-197 Plot of Sighting Positions with Marine Mammals (IPB, 2013)

The spotted dolphins forming large groups were from the Bottlenose species. The Spinner Dolphin was also often seen in groups with the bottlenose dolphin. A large group of bottlenose dolphins were found in the western area of Bintuni Bay, surrounding the most eastern of TEAP drilling wells. Meanwhile, more *Sousa chinensis* were encountered in coastal areas (intertidal areas) in the northern of the bay. Based on the observation results, there were dolphins nursing their offspring appeared (**Figure II-198).**

Marine mammals nursing their offspring were found in the Bintuni Bay indicating that the conditions of the Bintuni Bay are good enough for supporting/caring for their offspring, until they are strong enough to return to the open sea. The group of dolphins generally enters the Bintuni Bay as a group, particularly the bottlenose or *Tursiop truncates.* (**Figure II-199).**

Figure-198 **Some Appearances of Marine Mammals Seen Together with Juveniles**

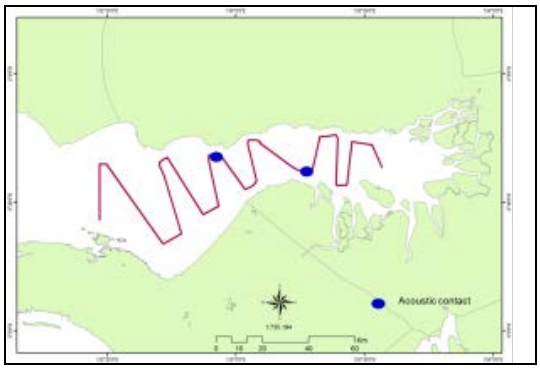
Figure -199 **Indo-Pacific Bottlenose Dolphin Group (*Tursiop truncatus*) in the Bintuni Bay**

The results of this mammal observation strengthen the previous study results that at least there were several main dolphin species, which are the Indo-Pacific Humpback Dolphin (*Sousa chinensis)*, Spinner Dolphin (*Stenella longirostris)*, Common bottlenose Dolphin (*Tursiops truncatus)* and *Tursiops aduncus* bottlenose dolphin inhabiting the waters of Bintuni Bay. Meanwhile, the existence of whales expected to be seen from the survey results (May 1st, 2013) still need to be understood further.

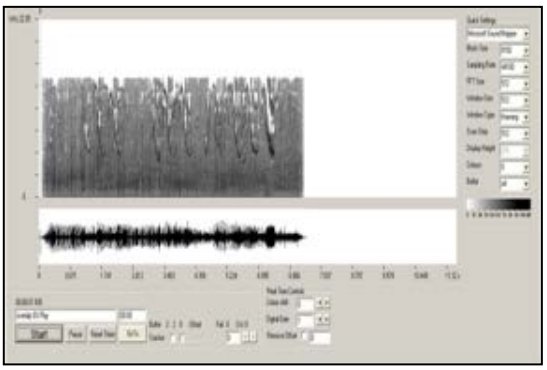
Apart from visual observation data, acoustic observation data also indicated an interesting situation. From eight acoustic observation points proposed, two acoustic contact points with marine mammals were found, and some noises were also recorded to be suspected as the sounds of benthic organisms such as shrimps and small fishes. Acoustic data indicated clicking sounds recording that were suspected as the sound of dolphins echo locating to look for food (frequency 13 – 5 Khz).

If connected to the quite high level of water productivity that occurs almost throughout the year such as seen from the results of the chlorophyll-a analysis in **Figure II-201** and **Figure II-202,** then it is suspected that Berau/Bintuni Bay is a habitat appropriate for the living place for these aquatic animals. The quite abundant food supply, including planktons, will attract various fish species that eventually will provide food sources for predators higher up, including marine mammals and reptiles. The Berau/Bintuni Bay does not only supply food sources,

but the conditions of the bay waters are calm and relatively protected from strong ocean energy that will provide benefits for these animals to regenerate and raise their offspring (nursery ground).



(a)



(b)

Figure II-200 (a) Acoustic Contact Location, and (b) Sample of Dolphin Sound Sonogram

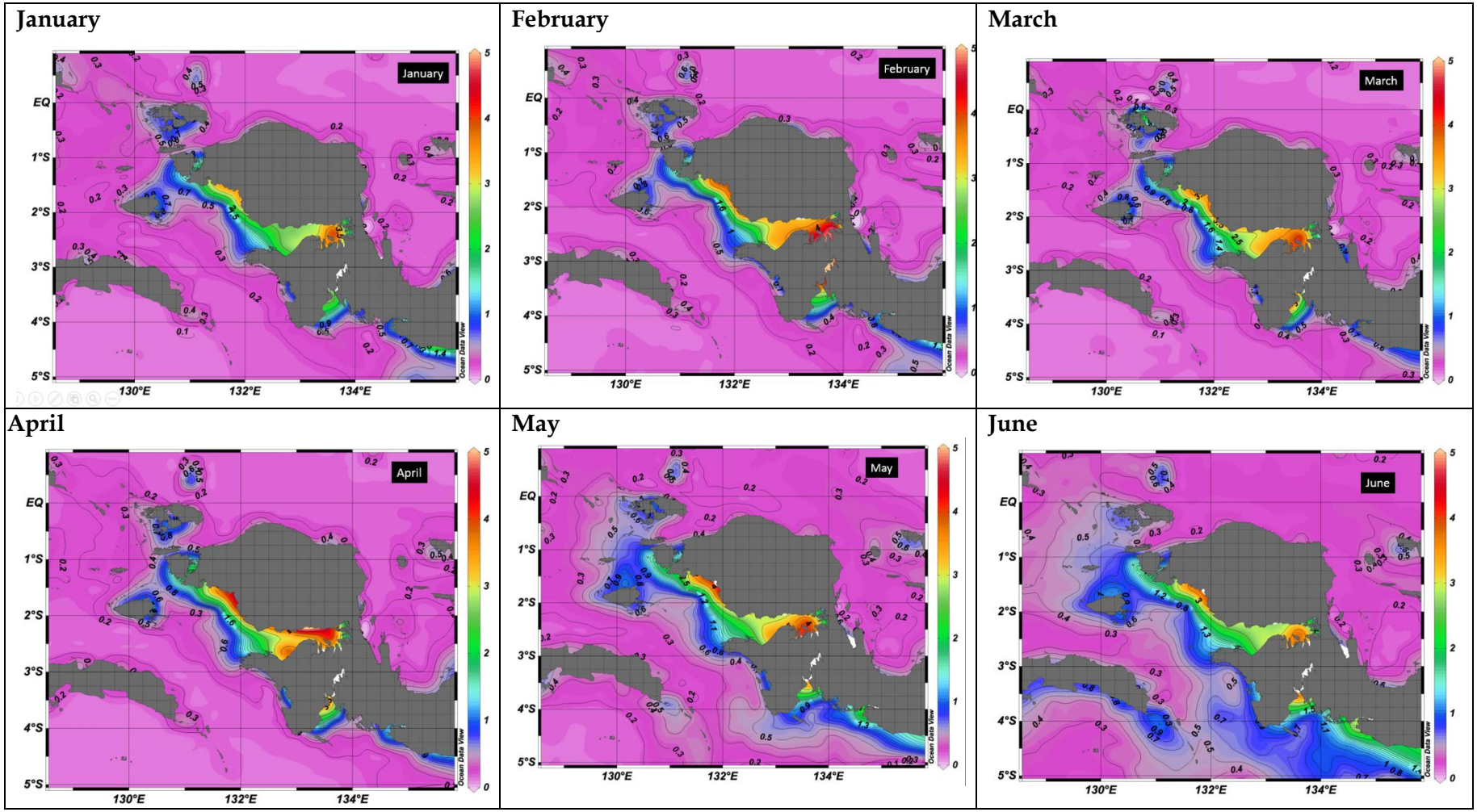


Figure II-201 Average Distribution of Chlorophyll-a (in mg/m³) from January-June in Bintuni Bay and Surrounding Waters

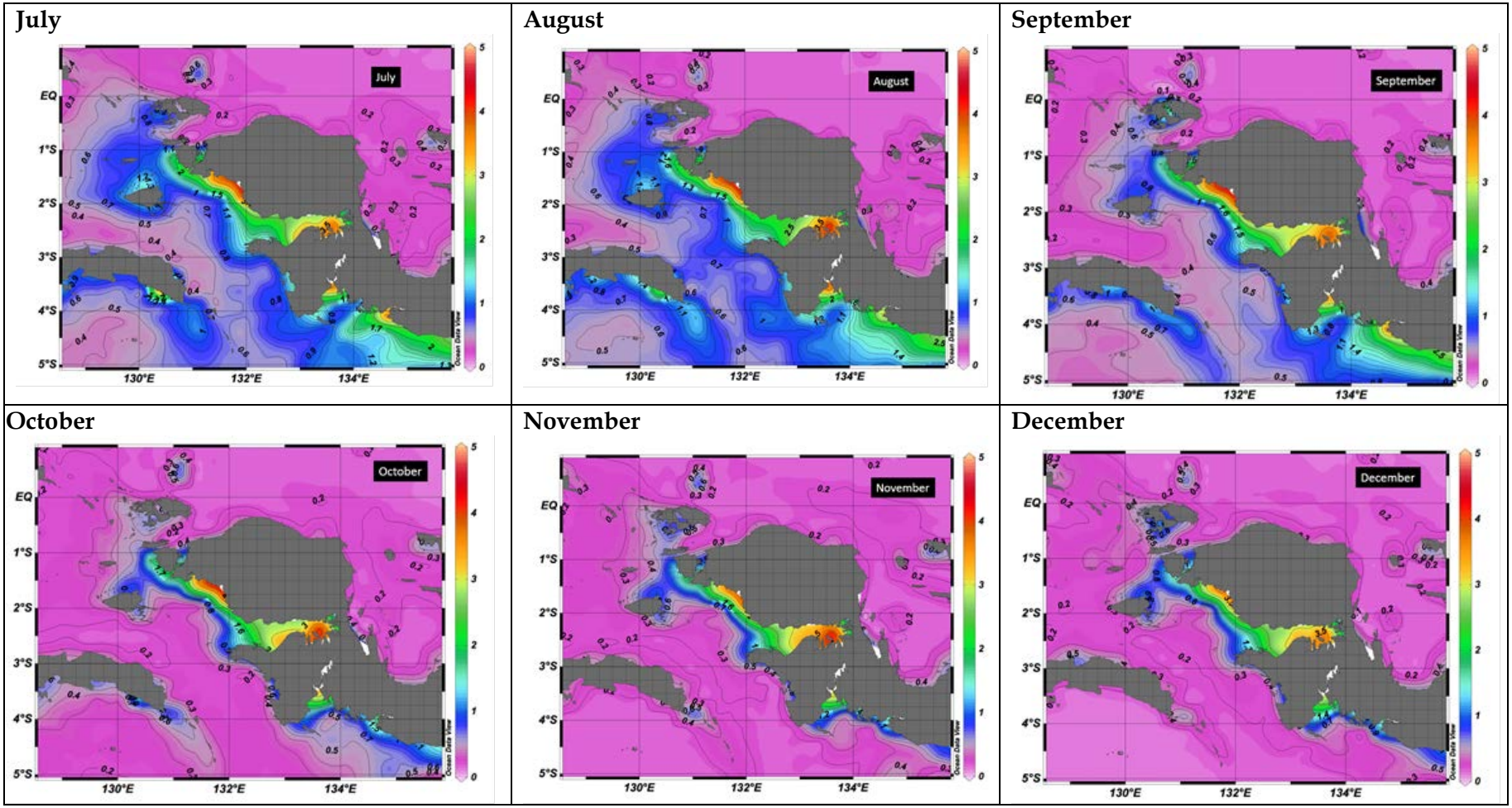


Figure II-202 Average Distribution of Chlorophyll -a (in mg/m³) from July-December in Bintuni Bay and Surrounding Waters

Meanwhile, many marine mammal species were found in the Berau/Bintuni Bay, but this wasnot the case for marine reptiles which they were not found during the survey. This did not indicate that there were no marine reptile species (particularly turtles) in the waters of the Berau/Bintuni Bay, but there were many factors that may cause the marine reptiles not be found during the survey, among others:

1. Direct observation time that was only conducted in one observation period; and
2. Limitations of observers to conduct visual observation, because turtles sighting at the surface usually occurs extremely briefly and difficult to be observed.

The collection of additional data regarding marine mammals and reptiles is still being done, one of the methods used is by conducting community interviews and also conducting an analysis on the by-catch results of the fishermen. In previous researches, turtles and dolphins were known to also often get caught in nets operated by local fishermen, thus to identify the definite species of an animal that is caught, this method is considered relevant enough. Apart from that, the location distribution of these animals can also be identified from the information of fishermen by identifying and mapping out their catch area.

Based on secondary data from research and observations made previously such as explained above, it was identified that there were at least four turtle species in the waters of Berau/Bintuni Bay, which were the Green Turtle, Hawksbill Sea Turtle, Olive Ridley Turtle, and Leatherback Sea Turtle, although their migration seasons and locations were not known for sure. Several locations with sandy beaches such as Ogar Island and Pisang Island located in the western of the Berau/Bintuni Bay have also been identified as nesting grounds for several turtle species. Therefore, the conclusion can be drawn that Bintuni Bay is also an important ecosystem for marine turtles.

Distribution and Protection Status of Marine Mammals and Reptiles in the Berau/Bintuni Bay

In general, all of the marine mammal and reptile species found have a wide distribution in the world and inhabit habitats in tropical to sub-tropical regions. In addition, these species are generally also protected animals because they play extremely significant roles for the marine environment (ocean regulator) with several of them declining in population.

Figure II-203 and **Figure II-204** is the distribution area and also the protection status of marine mammals and marine turtle species encountered in the Berau/Bintuni Bay.

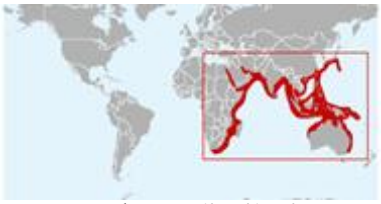
 (www.planet-mammifees.org)  *Balaenoptera brydei* **(Kahn, 2006)**	 *Balaenoptera brydei* **whale distribution area (www.commons.wikimedia.org)**	IUCN: Data Deficient Version 2013.1. CITES: -
 *Sousa chinensis* **(Wibowo N; Bintuni, 2011)**	 *Sousa chinensi* **distribution area (www.cms.int)**	IUCN: Near Threatened Version 2013.1. CITES: Appendix II
 *Stenella longirostris* **(Wibowo N; Bintuni, 2010)**	 *Stenella longirostris* **Distribution Area (www.cms.int)**	IUCN: /Data Deficient Version 2013.1. CITES: Appendix II
 *Tursiops aduncus* **(www.ryanphotographic.com)**	 *Tursiops aduncus* **distribution area (www.itsnature.org)**	IUCN: /Data Deficient Version 2013.1. CITES: Appendix II
 *Tursiops truncatus* **(IPB; Bintuni, 2013)**	 *Tursiops truncates* **distribution area (www.commonswikimedia.org)**	IUCN: Least Concern Version 2013.1. CITES: Appendix II

Figure II-203 Marine Mammal Species and Distribution Area Also Found in Bintuni Bay

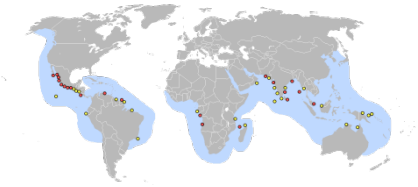
 *Eretmochelys imbricate* **(Wibowo N, Bintuni, 2010)**	 **Hawksbill Sea Turtle/ *Eretmochelys imbricate distribution area*** **(www.wikipedia.org)**	IUCN: Critically Endangered Version 2013.1 CITES: Appendix II
 *Lepidochelys olivacea* **(Wibowo N; Bintuni, 2009)**	 **Olive Ridley Turtle/ *Lepidochelys olivacea* distribution area** **(www.wikipedia.org)**	IUCN: Vulnerable Version 2013.1 CITES: Appendix II
 *Dermochelys coreacea* **(Wibowo N; Bintuni, 2010)**	 **Leatherback Sea Turtle/*Dermochelys coreacea* distribution area** **(www. wikipedia.org)**	IUCN: Critically Endangered Version 2013.1 CITES: Appendix II
 *Chelonia mydas* **(Kahn; Bintuni, 2006)**	 **Green Turtle/*Chelonia mydas* distribution area** **(www.wikipedia.org)**	IUCN: Endangered Version 2013.1 CITES: Appendix I

Figure II-204 Marine Reptile Species and Distribution Area Also Found in Bintuni Bay

Remarks:

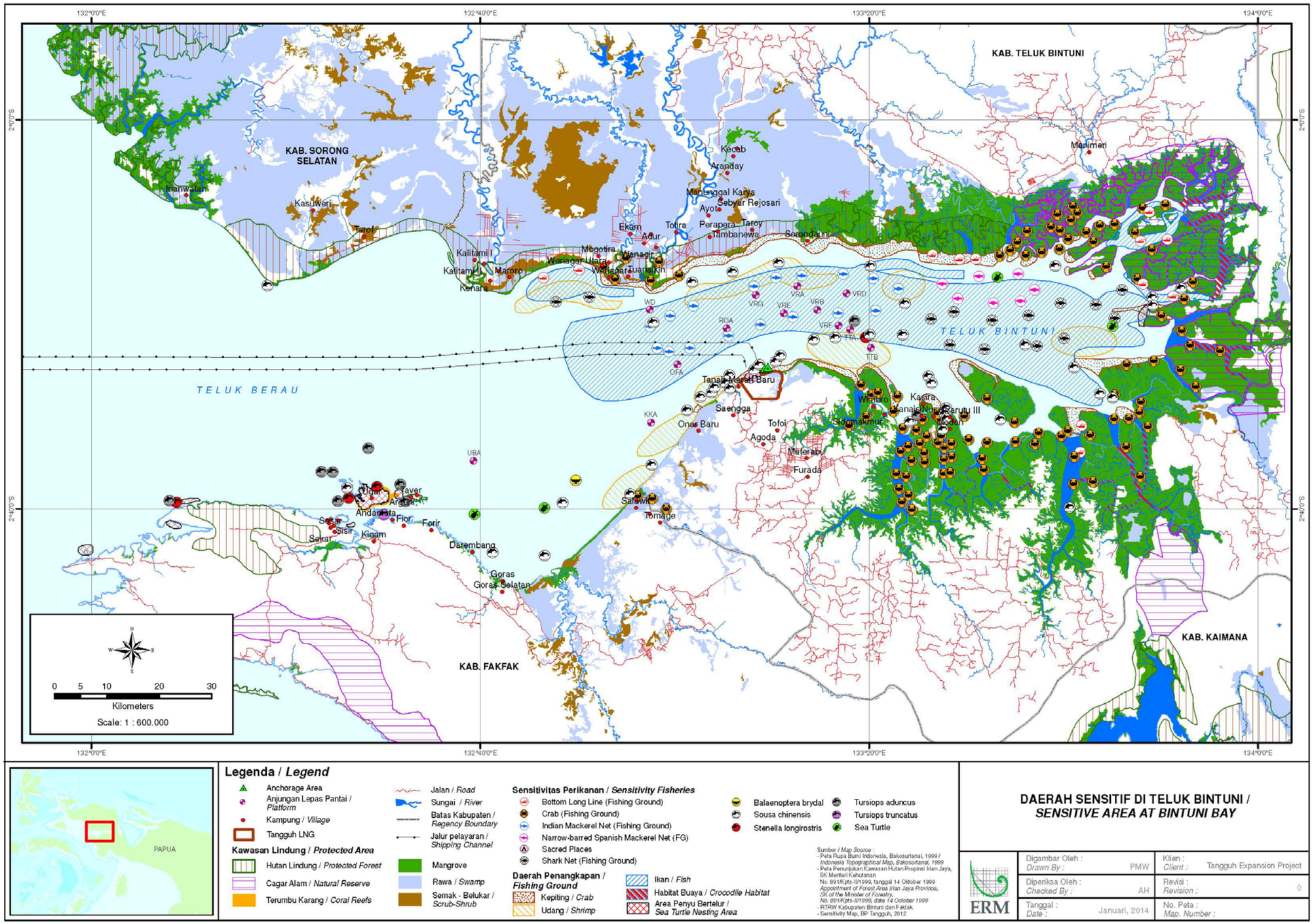
Conservation status according to IUCN Red List are grouped into:

- ***Extinct* (EX).** Conservation status given to species and sub-species that are certainly no longer found in their natural habitat.

- ***Extinct in The Wild*** **(EW).** The EW conservation status states when a species or sub-species are certainly no longer found in their natural habitat. But the species still remain or are found in captivity outside their natural habitat.
- ***Critically Endangered*** **(CR).** This conservation status is given to flora and fauna facing the risk of extinction in the near future, difficult to find their existence in their natural habitat.
- ***Endangered*** **(EN).** This conservation status states the status of flora and fauna facing high risk of extinction in the wild or their natural habitat. This status is one level lower compared to CR. The difference lies in the indications on extinction criteria.
- ***Vulnerable*** **(VU).** This condition is the initial limit of the conservation status of flora and fauna stated to be on the brink of extinction. This means that the flora and fauna can be said to be facing the threat or risk of extinction in their natural habitat.
- ***Near Threatened*** **(NT).** Conservation status stating that the flora and fauna conditions are believed to be nearing the threat of extinction in the wild. NT is usually issued for flora and fauna groups expected to be included in the VU category.
- ***Least Concern*** **(LC).** The LC conservation status is given to flora and fauna identified having no signs of meeting the EX, EW, ER, VU or even NT criteria.
- ***Data Deficient*** **(DD).** A taxon stated in DD condition when it is known that there is insufficient information that is directly or indirectly required to issue an estimation on the extinction risk criteria based on the distribution and/or status of the population.
- ***Not Evaluated*** **(NE).** A condition stating that when a taxon is identified for its conservation status, it has not been evaluated based on meeting the applicable criterions of conservation status according to the IUCN Red List guidelines.

Animal and plant species under the supervision of CITES are categorized into three groups, which are:

- ***Appendix*** **I** is the list of all plant and wildlife species prohibited in all forms of international trade.
- ***Appendix*** **II** is the list of species that are not endangered, but may be endangered if trade continues without any regulations. ***Appendix*** **III** is the list of plant and wildlife species protected in certain countries within the boundaries of their habitat area, and at any given moment, their rating could be raised to Appendix II or Appendix I.



Map II-198 Sensitive Areas of the Bintuni Bay Waters