

3.3 Ecological environment

3.3.1 Terrestrial organisms

3.3.1.1 Terrestrial plants

(1) Flora

1) Overview of flora

Flora in the evaluated area belongs to tropical Asia (India—Malaysia) region. This region

is closely linked with Eastern Himalaya region in its north, and valleys of Salween River taken as boundaries between China region in its east. Floristic elements in this region presents with convergence between east and west and compatibility between north and south.

Tropical Southeast Asia elements take a majority part in floristic elements of vegetations, followed by other elements in tropical zones. Vegetations are mostly covered by woody plants, among which many families and genera are direct descendants or relics of palaeotropical elements during Tertiary period.

2) Species composition

According to terrestrial plant survey and evaluation achievements, there are 1919 species, 845 genera and 201 families of vascular plants in the evaluated area, among which, 1735 species, 750 genera and 152 families of Angiosperm, 7 species, 5 genera and 5 families of Gymnospermae and 177 species, 90 genera and 44 families of Pteridophyta. Check list of Terrestrial vascular plants in evaluated area is in appendix 2.

3) Distribution features of flora

According to the distribution patterns, there are 31 cosmopolitan distribution families of Angiosperm, which accounts for 20.4% of Angiosperm; 72 Old World Tropics distribution families of Angiosperm, which accounts for 47.4% of Angiosperm; 9 tropical Asia--tropical America disjunct distribution families of Angiosperm, which accounts for 5.9% of Angiosperm; 5 Old World distribution families of Angiosperm, which accounts for 3.3% of Angiosperm; 20 North Temperate distribution families of Angiosperm, which accounts for 13.2% of Angiosperm. There is 1 family of Gymnospermae of cosmopolitan distribution, East Asia distribution and temperate zone respectively, accounting for 20% of Gymnospermae respectively; 2 families in pantropical distribution, accounts for 20% of Gymnospermae. There are 13 families of Pteridophyta of cosmopolitan distribution, accounts for 29.6% of Pteridophyta; 26 families of Pteridophyta of pantropical distribution, accounting for 59.1% of Pteridophyta, 1 family of Pteridophyta of pantropical

distribution, tropical Asia and tropical American disjunct distribution ,Old World Tropics distribution, tropical Asia to tropical Australia distribution, tropical Asia to tropical Africa distribution, and tropical Asia distribution respectively, accounting for 2.3% of Pteridophyta respectively.

Based on the distribution pattern system of Wu Zhengyi et.al (2006), vascular plant families in evaluated area can be divided into 13 distribution patterns (Table 3.3-1), and seed plants genera in evaluated area can be divided into 15 distribution patterns (Table 3.3-2) .

Table 3.3-1 List of distribution patterns of vascular plant families in evaluated area

Distribution patterns	Angiosperm		Gymnospermae		Pteridophyta	
	Number of families	Percentage accounting for total families (%)	Number of families	Percentage accounting for total families (%)	Number of families	Percentage accounting for total families (%)
1. Comsmopolitan	31	20.4	1	20	13	29.6
2.Pantropic	72	47.4	2	40	26	59.1
3. Tropical Asia and tropical American disjuncted	9	5.9			1	2.3
4. Old World Tropics	5	3.3			1	2.3
5. Tropical Asia to Tropical Australia	3	2.0			1	2.3
6. Tropical Asia to Tropical Africa	2	1.3			1	2.3
7. Tropical Asia	4	2.6			1	2.3
8. North Temperate	20	13.2		20		
9. East Asia and North America disjuncted	3	2.0				
10.East Asia	1	0.7	1	20		
11. Mediterranean, West Asia to Central Asia	1	0.7				
13. Temperate			1			
16. Extratropical S. Hemisphere disjuncted or dispersed	1	0.7				
Total	152	100	5	100	44	100

4) Floristic characteristics

Through observing distribution patterns of seed plants genera, the flora in evaluated area

possessing the following features: ① Richness of tropical elements.

There are 555 genera in tropical genera of plants in evaluated area (Pattern 2 to 7) ,accounting for 73.5% of total genera (Genera under cosmopolitan distribution are excluded), among which, 377 genera are totally under tropical distribution. In general view, plant species with tropical elements take a majority part in this area, mainly covered by trees and shrubs, are mostly constructive species or dominant species of forest plant communities. Additionally, herbaceous plants and climbing plants also are relatively a lot. The existence of such species demonstrates that flora in the evaluated area has rather significant tropical elements, and shows typical features of tropical and subtropical vegetations.

Table 3.3-2 List of distribution patterns of seed plant genera in evaluated area

Distribution patterns	Number of genera	Percentage taking up in total genera (%)
1. Cosmopolitan	46	6.1
2. Pantropic	178	23.6
3. Tropical Asia and tropical America disjuncted	41	5.4
4. Old World Tropics	69	9.1
5. Tropical Asia to tropical Australia	46	6.1
6. Tropical Asia to tropical Africa	54	7.2
7. Tropical Asia	167	22.1
8. North Temperate	62	8.2
9. East Asia and North America disjuncted	28	3.7
10. Old World Temperate	19	2.5
11. Temperate Asia	3	0.4
12. Mediterranean, West Asia to Central Asia	4	0.5
13. Central Asia	1	0.1
14. East Asia	34	4.5
15. Endemic to China	3	0.4
Total	755	100

② Flora elements in North Temperate takes a larger proportion

There are 62 genera in flora elements in North Temperate in evaluated area, accounting for 8.2% of total genera (Genera under cosmopolitan distribution are excluded). The representing genera include *Acer*, *Rhus*, *Angelica*, *Arisaema*, *Asarum* and *Artemisia* etc. As a part of temperate flora, these genera occupy a significant position in each plant community in this area.

③ Cosmopolitan is the third largest element in this area

There are 46 genera under cosmopolitan distribution in evaluated area, accounting for 6.1% of total genera. The representing genera include *Amaranthus*, *Bidens*, *Erigeron*, *Gnaphalium*, *Senecio* and *Xanthium*, etc. Flora elements under cosmopolitan distribution in this district mostly are herbaceous plants, with plants from the following four herbaceous species taking absolutely percentages, e.g. Asteraceae, Brassicaceae, Poaceae and Cyperaceae. These species are widely distributed in evaluated area, particularly significantly distributed in secondary forests, tertiary forests, ground forests and wetlands at edges of forests.

(2) Vegetation types and distribution characteristics

1) Vegetation types

By reference to the monographs such as “Vegetation of Yunan”, “Plants of GaoliGongshan” and “Vegetation of China”, in combination with analysis on appearances of constructive species and dominant species of existing vegetations, ecological environments and geographical distribution characteristics in communities in evaluated area, the vegetations in evaluated area are divided into 7 vegetation types, 9 vegetation sub-types and 20 communities. Vegetation types in evaluated area are listed in table 3.3-3 and attached figure 9.

① Humid rainforests

Form. *Dipterocarpus* spp. and *Shorea* spp.

The upper stream of Ayarwaddy River above Myitkyina is dominated by valley rainforests communities covered by *Shorea* sp. and *Dipterocarpus turbinatus* Gaertn .f. as dominant plants, middle stream dominated by monsoon rainforests communities covered by *Tectona gr. andis*, *Terminalia tomentosa*, *Xylia xylocarp*, *Dipterocarpus* spp. etc. as dominant plants,



Form.Dipterocarpus spp. forest

and lower stream dominated by off-shore rainforests communities covered by *Dipterocarpus* spp. and *Shorea* spp. as dominant plants on low lands. Due to influence of artificial disturbance, a large scale of indigenous valley rainforests are hardly discovered within this district, just a small part of valley rainforests under relatively indigenous state are distributed in partial area.

② Semi-evergreen monsoon rainforests

a. Form. *Tetrameles nudiflora*

Form. *Tetrameles nudiflora* is dominated by *Tetrameles nudiflora* on top layer, and by *Symplocos* sp., *Litsea* sp., *Diospyros* sp., *Areca triandra*, *Baccaurea capita* etc. on middle and lower layer. This area is classified into valley tropical rainforests type with strong indigenous features, and



Form.Tetrameles nudiflora

mainly distributed in Myitsone area, occasionally seen in lower part of mountains with a small area geneally occupying, presented like small piece shape.

b. Form. *Duabanga grandiflora*., *Chukrasia* sp. and *Polyalthia* spp.

Form. *Duabanga grandiflora*., *Chukrasia* sp. and *Polyalthia* spp. are classified into

secondary valley rainforests type occurring frequently in this district , mainly distributed in Chibwe sections and often seen in valleys of lowlands and lower part of mountains, generally at an altitude about 300 mm.

c. Form.*Ficus sp.*, *Spondias sp.* and *Caryota gigas*

Form. *Ficus sp.*, *Spondias sp.* and *Caryota gigas* cluster is mainly featured with large palm plant miscellancous forests covered by *Caryota gigas* and *Caryota urens*, which are mainly distributed in valleys of Kaunglanhpu, Pisa and Wutsok sections and lower part of mountains, presented as a small piece.



Form. *Duabanga grandiflora*



Form. *Ficus sp.*, *ASpondias sp.* and *Caryota gigas*

Table 3.3-3 List of vegetation types in evaluated area

Vegetation types	Vegetation sub-types	Formations	Distribution status
Tropical rainforests	I .Humid rainforests	1.Form. <i>Dipterocarpus spp.</i> , <i>Shorea spp.</i>	Mainly distributed in low lands, lower part of mountains and valley sections.
Tropical monsoon forest	II .Non-evergreen monsoon forest	2.Form. <i>Tetrameles nudiflora</i>	Occasionally distributed in lower part of mountains and presented as a small piece.
		3.Form. <i>Duabanga grandiflora.</i> , <i>Chukrasia sp.</i> , <i>Polyalthia spp.</i>	Often seen in low lands, valleys and lower part of mountains with an altitude of 300m.
		4. Form. <i>Ficus sp.</i> , <i>Spondias sp.</i> and <i>Caryota gigas</i>	Mainly distributed in valleys and lower part of mountains of Kaunglanhpu, Pisa and Wutsok sections, presented as a small piece.

Table 3.3-3

List of vegetation types in evaluated area

Vegetation types	Vegetation sub-types	Formations	Distribution status
Evergreen broad-leaved forests	III Monsoon evergreen broad-leaved forests	5. Form. <i>Castanopsis indica</i>	Generally distributed in middle and upper part of mountain slopes with an altitude within 200 ~ 300m.
		6. Form. <i>Castanopsis</i> sp.	Generally distributed in middle and upper part of low mountain slope with an altitude of about 400m.
		7. Form. <i>Castanopsis diversifolia</i> , <i>C. acuminatissima</i>	Generally distributed in middle of middle mountain slope with an altitude of 1000m.
		8. Form. <i>Castanopsis calathiformis</i>	Mainly distributed in middle and upper part of low mountain slope with an altitude of 500m in Pisa and Wutsok sections, generally presented as a small piece.
Evergreen broad-leaved forests	III Monsoon evergreen broad-leaved forests	9. Form. <i>Castanopsis tribuloides</i>	Generally distributed in middle and upper part of middle mountain slope with an altitude of 1000m.
		10. Form. <i>Schima wallichii</i>	Mainly distributed in Chibwe and Myitsone sections and presented as a small piece.
		11. Form. <i>Alnus nepaulensis</i> and <i>Engelhardtia spicata</i>	Mainly distributed in middle and upper part of mountain slopes in Kaunglanhpu and Chibwe sections.
		12. Form. <i>Symplocos</i> spp.	Mainly distributed in middle and upper part of mountain slopes in Yenans sections.
Tropical sparse tree-bamboo forests	IV. Wet sparse bamboo forests	13. Form. <i>Bombax ceiba</i> , <i>Tetrameles nudiflora</i> and <i>Dendrocalamus</i> spp.	Mainly distributed in low lands and lower part of mountain slopes.
Tropical sparse musa forests	V. Wet sparse musa forests	14. Form. <i>Shorea</i> sp., <i>Tetrameles nudiflora</i> and <i>Musa</i> spp.	Generally distributed in sections with a high humidity and also seen in sections where human activities occurs frequently in relative sense.
Shrub and shrubs	VI. Tropical evergreen shrubson the uncultured lands	15. Comm. <i>Alangium</i> spp., <i>Bauhinia</i> spp.— <i>Mikania micrantha</i> and <i>Eupatorium odoratum</i>	Generally distributed in village dwelling, roadside and uncultured lands like shape or presented as a small piece.
	VII. Tropical river beach shrubs	16. Comm. <i>Homonoia riparia</i> — <i>Rosa</i> sp.— <i>Arundo donax</i>	Distributed in rivers on both banks of Nmai Kha River and Malikha River incontinuously.
Artificial Vegetation	VIII. Wood artificial vegetations	17. Plantation of <i>Hevea brasiliensis</i>	Distributed largely in Ben-bane district in Myitsone sections.
		18. Plantation of <i>Citrus</i> spp.	Mainly distributed in Ben-bane district in Myitsone sections and sporadically distributed in Chibwe.
	IX. Grass artificial vegetation	19. Farmland	Distributed in adjacent of Leidan village in east bank of Nmai Kha River, Kaunglanhpu and Poland village in west bank of Nmai Kha River in Kaunglanhpu sections, Linmao village in Chibwe sections, Baoniao village and Maliya village in Laza sections and Ben-bane district in Myitsone sections.
		20. Slope farmland (Shifting Cultivation)	Often distributed largely in mountain slopes nearby counties and villages.

③ Monsoon evergreen broad-leaved forests

a. Form. *Castanopsis indica*

Form. *Castanopsis indica* is one of common vegetation types belonged to secondary wet rainforests in this district, and also is one major kind of *Castanopsis* formation in this district. It is mainly distributed in middle and upper part of mountain slopes with altitude from 200 to 300 m in Myitsone sections.

b. Form. *Castanopsis* sp.

Form. *Castanopsis* sp. community is distributed in Chibwe and Laza sections, classified into one kind of *Castanopsis* formations in secondary tropical rainforests, and generally distributed in middle and upper part of mountain slopes in low mountains with an altitude of about 400 m.

c. Form. *Castanopsis diversifolia*, *C. acuminatissima*

Form. *Castanopsis diversifolia* and *C. acuminatissima* are secondary forests formed after original tropical humid rainforests degrade due to destroy to a limited extent, and one kind of *Castanopsis* formations often occurring in this district. It is mainly distributed in middle of medium mountains in Kaunglanhpu sections at an altitude of about 1000m.

d. Form. *Castanopsis calathiformis*

Form. *Castanopsis calathiformis* is one kind of *Castanopsis* formations often occurring in this district. It is mainly distributed in middle and upper part of low mountains in Pisa and Wutsok sections at an altitude of about 500m, generally presented as a small piece.

e. Form. *Castanopsis tribuloides*

Form. *Castanopsis tribuloides* is one kind of *Castanopsis* formations often occurring in this district and one of *Castanopsis* formations occupying a larger area in this watershed. It is mainly distributed in middle and upper part of high mountains in Yenan sections at an altitude of about 1000m.

f. Form. *Schima wallichii*

Form. *Schima wallichii* is one kind of secondary forests community often occurring in this district, which is often incontinuously distributed with *Castanopsis* formations with strong secondary features. It is largely distributed in Chibwe and Myitsone sections, and generally presented as a small piece.

g. Form. *Alnus nepaulensis* and *Engelhardtia spicata*

Form. *Alnus nepaulensis* and *Engelhardtia spicata* is one community with strong secondary features, taking its dominant tree specified as leading species, classified into communities when tropical rainforests are recovering at early stage under serious influence of disturbance. It is mainly distributed in middle and upper part of mountain slopes in Kaunglanhpu and Chibwe sections.

h. Form. *Symplocos* spp.

Form. *Symplocos* spp. is one kind of community with strong secondary features, showing common elements and types in community, whereas have numerous numbers in individual type, classified into community when humid rainforests are evolving at early stage under serious influence of disturbance. In this community, leading species take a majority part in community elements, and distributed in middle and upper part of mountain slopes in Yenau sections.



Form. *Castanopsis indica*



Form. *Symplocos* spp.



Form. *Alnus nepaulensis* and *Engelhardtia spicata*



Form. *Schima wallichii*

④ Humid sparse tree and bamboo forests

Form. *Bombax ceiba*, *Tetrameles nudiflora* and *Dendrocalamus spp.*

Form. *Bombax ceiba*, *Tetrameles nudiflora* and *Dendrocalamus spp.* is one of vegetation types distributing to a largest extent in the evaluted area, approximately accounting for more than 60% of total area of evaluted area. This community belongs to secondary vegetations formed after tropical rainforests are destroyed artificially. It is similar with sparse monsoon rainforests community with respect to its appearance. Leaves of trees on top layer may fall down in dry season. In lower part of low lands and mountain slopes, trees on top layer of deciduous big trees are ailhouetted above canopy, e.g. *Tetrameles nudiflora* and *Bombax ceiba*.

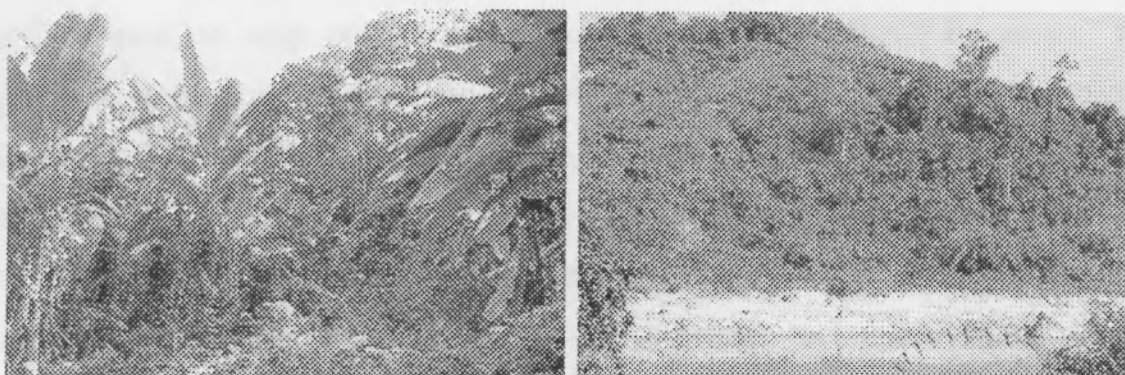


Humid sparse tree and bamboo forests

⑤ Humid sparse tree and musa forests

Form. *Shorea* sp., *Tetrameles nudiflora* and *Musa* spp.

Community of Form. *Shorea* sp., *Tetrameles nudiflora* and *Musa* spp. is similar with Form. *Bombax ceiba*, *Tetrameles nudiflora* and *Dendrocalamus* spp. with respect to its appearance, whereas have relatively fewer deciduous elements, taking *Shorea* sp., , *Dipterocarpus* spp., *Bischofia* sp. and *Ficus* spp. as dominant species on top layer, with a certain quantity of *Tetrameles nudiflora* and *Bombax ceiba* distributed. It is mainly distributed in sections with a large humidity, e.g. lower part of mountain slope, mountain valley and uncultured land, etc, and also largely distributed in sections where artificial activities frequently take place.



Humid sparse tree and musa forests

⑥ Tropical roadside evergreen shrubs and herbs on the uncultured lands

Comm. *Alangium* spp., *Bauhinia* spp.—*Mikania micrantha* , *Eupatorium odoratum*

Comm. *Alangium* spp., *Bauhinia* spp.—*Mikania micrantha*, *Eupatorium odoratum* is classified into one vegetation type formed after tropical regions degrade under artificial



repeated disturbances. The community is presented like shrubs shape, covered by major shrub species like *Alangium spp.*, *Bauhinia spp.*, *Zizyphus jujubus*, *Atalantia buxifolia*, *Streblus asper*, *Sageretia theezans*, *Mallotus japonicus*, *Macaranga tanarius*, *Ficus hispica*, *Fic simplicissima*, *F. fulva*, *Trema sp.*, *Maesa japonica* and *mCaesalpinia sp.* It is one kind of vegetations often seen in this district, whereas generally distributed like stripe or small pieces shape in village dwelling, roadside and uncultured lands where human activities often take place in Myitsone, Chibwe, Yen-an and Kaunglanhpu.

⑦ Tropical river beach shrubs

Comm. *Homonoia riparia*—*Rosa sp.*—*Arundo donax*

Comm. *Homonoia riparia*—*Rosa sp.*—*Arundo donax* is one type of representing vegetations in Asian tropical river beaches, showing a alternative change from wet to dry season with respect to its specifies elements and morphologic characteristics. *Homonoia riparia* (Euphorbiaceae) is characteristical species exclusively appearing in Asian tropical river beaches, not only distributed in Myanmar but also often observed in tropical regions of China, Laos and Vietnam. This community is majorly distributed in river beaches extending long on both banks of Nmai Kha River and Malikha River, often in incontinuous way, and generally occupying a larger area in beaches along river bends.

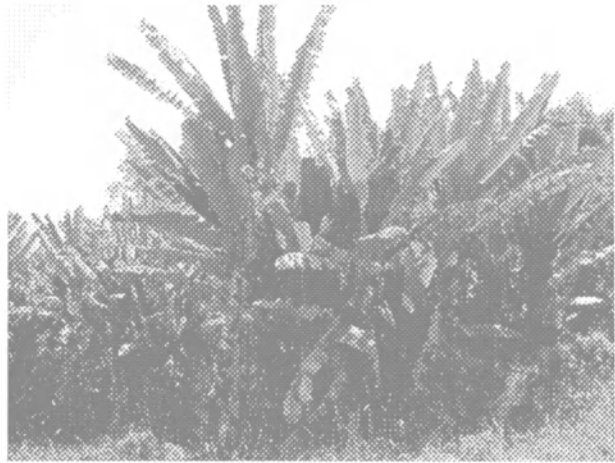


Tropical river beach grassland

⑧ Artificial vegetations

a. Plantation of *Hevea brasiliensis*

Plantation of *Hevea brasiliensis* is one significant plantation in this district, occupying an area above 2000hm², classified into one important vegetation type in wet and hot valleys, and distributed in Ben-bane places within Myitsone sections in quantity.



b. Plantation of *Citrus spp.*

Major Citrus species in plantation of *Citrus spp.* include orange, tangerine, lemon and pomelo, majorly distributed in Ben-bane places of Myitsone sections and sporadically distributed in Chibwe sections.



⑨ Artificial grass vegetation

a. Farmland of *Oryza indicum*, *O. japonica*

Paddy rices are mainly cultivated in farmlands, and distributed in adjacent of Ridan village in east bank of Nmai Kha River, Kaunglanhpu and Poland village in west bank of Nmai Kha River in Kaunglanhpu sections, Linmao village in Chibwe sections, Baowu village and Maliyang village in Laza sections, Ben-Bane places in Myitsone sections with a certain scale.

b. Slope cultivated lands (Shifting cultivation. *Brassica sp.*, *Zea mays*, *Panicum sp.*, *Sorghum sp.*)

Major crops planted in slope cultivated lands are *Brassica sp.*, *Zea mays*, *Panicum sp.*, and *Sorghum sp.*, which are distributed on both banks of Kaunglanhpu sections, east bank

of Ridan village, Tuoke village, Maoma village, Kakong village and Baola village in Chibwe sections, Huowang village, Fan Nanya village and Maliyang villages in Laza sections, Ben-Bane places in Myitsone sections, Wapei village and Dong Basha village in Pisa and Wutsok sections. There is a large area of slope cultivated lands or shifting cultivation relics in mountain slopes nearby Nan Ban Nading village in Yenan sections.

2) Distribution features of vegetations

Vegetations in this district takes wood plants as dominant species, among which, many families and genera of such plants are direct descendents or relics of tropical flora of ancient tertiary. The vegetation of this district is characterized by Form. *Dipterocarpus spp.* and symbolized by some species of families endemic to Southeast Asia such as Crypteroniaceae and *Tetrameles nudiflora*, which indicates that vegetations in this district have genetic relation with typical tropical rainforests in Southeast Asia. However, in recent decades, due to influence of human disturbance, vegetations in tropical rainforests are mostly destroyed in evaluated area, only secondary tropical rainforests like small pieces shape are survived in some regions. A large area of vegetations reversely evolve into sparse tree and bamboo forests or sparse tree and musa forests by taking *Tetrameles nudiflora*, *Bombax ceiba* and *Ficus sp.* as dominant species with respect to the community elements.

① Vertical distribution

The evaluated area belongs to humid rainforests in zonal vegetation types, and currently takes sparse tree and bamboo forests, sparse tree and musa forests as dominant vegetations. Indigenous tropical valley rainforests covered by Form. *Dipterocarpus spp.* as dominant species occupies a large area in remote regions; Main stream regions in both rivers are mainly covered by secondary rainforests, which is alternatively distributed with sparse tree and bamboo forests as well as sparse tree and musa forests. Major vegetation types in evaluated area are sparse tree and bamboo forests, sparse tree and musa forests with sparse tree and bamboo forests occupying a larger area. Sparse tree and musa forests are only distributed in valley nearby villages or lower part of mountain slopes. Places at a higher altitude are mainly covered by evergreen broad-leaved forests with respect to

secondary forests type, which is alternatively distributed with sparse tree and bamboo forests, and sparse tree and musa forests.

Cascade power stations in development of hydropower has a large span in its altitude, normal water storage level at lowest point of Myitsone being 245m and normal water storage level at highest point of Yenam being 1010m. Generally speaking, the influence area of hydropower development is still located within tropical humid rainforests district; however, considering that the first ridge line on both sides of major river channels is taken as boundary of the evaluated area, thus vegetation types in evaluated area also include evergreen broad-leaved forests below the first ridge line. According to field survey and analysis on relevant literature material, Ayarwaddy Watershed is covered by humid rainforests at an altitude below 1000m, tropical monsoon rainforests at altitude from 1000m to 1500m; pantropical evergreen broad-leaved forests at altitude from 1500m to 2000m, and warm temperate deciduous broad-leaved forests at altitude from 2000m to 2400m, temperate hemlock forests at altitude from 2400m to 3000m, cold temperate spruce-fir forests at altitude from 3000m to 3500m, cold temperate bushes and alpine meadow at altitude from 3500m to 5500m, snow line above 4500 m. The vertical distribution status of vegetation types in evaluated area is seen in figure 3.3-1.

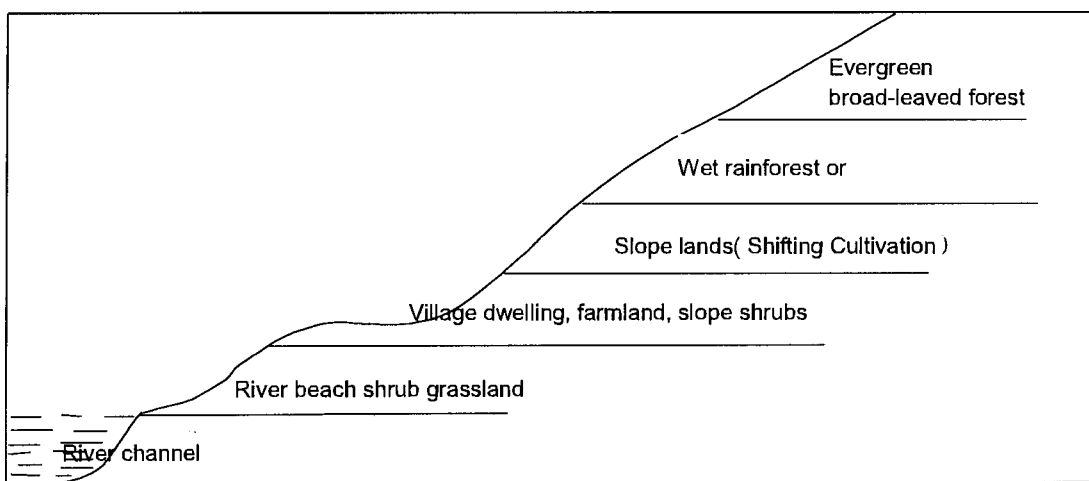


Figure 3.3-1 Diagram of vertical distribution of vegetation types in evaluated area

② Horizontal distribution

Due to influence by altitude height and artificial disturbance, the horizontal distribution in evaluated area is relatively complex, whereas it is covered by tropical rainforests taking Form. *Dipterocarpus spp.* as dominant species with respect to its zonal vegetation. Regarding secondary forests, the dominant species of secondary forests are different due to differences in regions; regarding sparse tree and bamboo forests, bamboo elements are different due to differences in regions; elements in bamboo species are different in different regions; As for stand forests elements, due to reasons of altitude and humidity within this area, a majority of large palm plants are seen in stand forests regions at higher altitude like *Caryota urens* and *Caryota gigas*, plam plants like *Areca triandra* seen within the forests at lower altitude.

Additionally, due to seasonal water rise and down occurring in rivers, river floodplain plants grow up on banks of rivers, e.g. *Syzygium sp.* , *Litsea salicifolia*, *Ardisia sp.*, *Eurya japonica* and *Homonoia riparia*.

(3) Rare and endangered plants and regional endemic plants

According to survey on terrestrial plants and evaluation achievements, it is totally found 12 rare and endangered plants in IUCN (World Conservation Union) Red List in evaluated area, including *Aquilaria malaccensis* Lam., *Tetrameles nudiflora*, *Mangifera sylvatica*, *Bhesa sinensis*, *Cephalotaxus griffithii* Hook. f., *Dipterocarpus turbinatus* Gaertn. f., *Dipterocarpus retusus*, *Taiwania cryptomerioides* Hayata, *Craibiodendron stellatum*, *Caesalpinia sappan* L., *Holarrhena pubescens* Wall. ex G.Don and *Bretschneidera sinensis* Hemsl. Additionally, species of *Cyathea spp.*, Orchidaceous species. and *Aquilaria malaccensis* Lam. listed in CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) Appendix II are sporadically distributed in reservoir submerging region. Specifies listed in CITES Appendix I are not discovered.

Based on the survey, two kinds of regional endemic plants are distributed in reservoir submergeing regions of Myitsone, which are *Camellia irrawadiensis* Barua and *Ampelocalamus kachinensis* N. H. Xia.

Distribution status of rare and endangered plants and regional endemic plants in evaluated area is seen in table 3.3-4 and attached figure 18.

Table 3.3-4 Distribution status lists of rare and endangered plants and regional endemic plants in evaluated area

No.	Name		IUCN	CITES	Geographical distribution	Altitude (m)	Relation with the planning cascade	Remarks
	Families names	Species names	Red List	Appendix				
1	Thymelaeaceae	Aquilaria malaccensis Lam.	VU	II	Tropical Asia	<1500	Chibwe , Wutsok and Pisa sections	
2	Datsiaceae	Tetrameles nudiflora	LR/LC		Tropical Asia,Australia	200 ~ 700	Myitsone, Chibwe , Wutsok , Pisa and Laza sections	
3	Anacardiaceae	Mangifera sylvatica	LR/LC		China, Indo-China peninsula, in Myanmar, India, Sikkim, Nepal	620 ~ 1900	Wutsok sections	
4	Celastraceae	Bhesa robusta (Roxb.) Ding Hou	LR/LC		China,India,Vietnam and Malaysia	50 ~ 500	Chibwe sections	
5	Cephalotaxaceae	Cephalotaxus griffithii Hook. f.	LR/LC		China,India,South east Asia	1100	Chibwe sections	
6	Dipterocarpaceae	Dipterocarpus turbinatus Gaertn. f.	CR		India, Pakistan, Myanmar, Thailand, Cambodia ,China	20 ~ 500	Myitsone, Laza and Chibwe sections	
7	Dipterocarpaceae	Dipterocarpus retusus	VU		Tropical Asia	<1100	Myitsone, Chibwe , Wutsok , Pisa and Laza sections	
8	Taxodiaceae	Taiwania cryptomerioides Hayata	VU		China	500 ~ 2000	Chibwe and Kaunglanhpu sections	
9	Ericaceae	Craibiodendron stellatum	LR/LC		China, India, Laos, Myanmar, Thailand, Vietnam	200 ~ 2700	Chibwe sections	
10	Caesalpinaceae	Caesalpinia sappan L.	LR/LC		India, Myanmar, Vietnam, Malay Peninsula, Sri Lanka,China	50 ~ 700	Myitsone sections	

Table 3.3-4 Distribution status lists of rare and endangered plants and regional endemic plants in evaluated area

No.	Name		IUCN Red List	CITES Appendix	Geographical distribution	Altitude (m)	Relation with the planning cascade	Remarks
	Families names	Species names						
11	Apocynaceae	Holarrhena pubescens Wall. ex G.Don	LC		India, Myanmar, Vietnam, Thailand, Laos, Cambodia, Malaysia, China	50 ~ 700	Myitsone sections	
12	Breetschneidaceae	Bretschneidera sinensis Hemsl	EN		China, Vietnam	500 ~ 1000	Myitsone, Chibwe , Wutsok , Pisa and Laza sections	
13	Cyatheaceae	Cyathea spp.		II	Tropical Asia	100 ~ 1500	Myitsone, Chibwe, Wutsok, Pisa, Laza , Kaunglanhpu and Yen-an sections	
14	Orchidaceae	Orchidaceae		II	Pantropical zone	A wide distribution on range	Myitsone, Chibwe , Wutsok, Pisa, Laza, Kaunglanhpu and Yen-an sections	
15	Theaceae	Camellia rrawadiensis Barua			Myanmar	<300	Myitsone sections	Regional endemic plants
16	Poaceae	Ampelocalamus kachinensis N. H. Xia			Myanmar	200	Myitsone sections	



Aquilaria malaccensis Lam.



Tetrameles nudiflora



Mangifera sylvatica



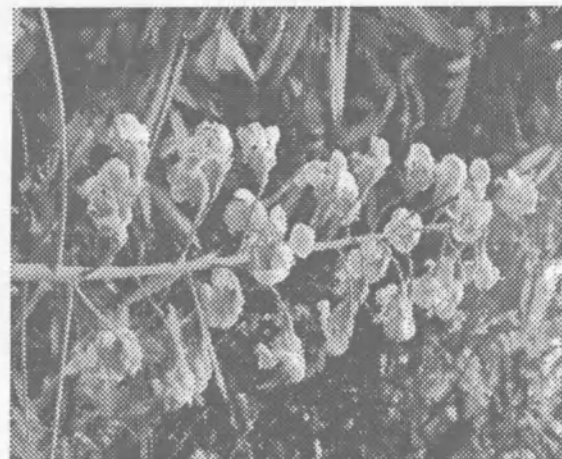
***Cephalotaxus griffithii* Hook. f.**



***Dipterocarpus turbinatus* Gaertn. f.**



Dipterocarpus retusus



***Bretschneidera sinensis* Hemsl**



***Caesalpinia sappan* L.**

3.3.1.2 Terrestrial animals

Results of the terrestrial animals in the evaluated areas are as following.

(1) Mammals

1) Species

There are 79 species being identified which belong to 8 orders and 28 families of all the mammals recorded. Among them, Carnivora is the most abundant accounted for 24 species and for 30.4% in total. There are 22 species accounted for 27.9% and 14 species accounted for 17.7% of Rodentia and Artiodactyla respectively. We also recorded 7 species of Chiroptera, 7 of Primates, 1 of Scandentia, 2 of Pholidota and 2 of Insectivora during the investigation.

2) Rare and endangered mammals

There are 21 endangered species accounting for 28.6% among 79 identified mammals. There are 15 species listed as vulnerable and 6 species listed as endangered in IUCN Red List. No critically endangered species are recorded.

Besides, 29 species accounting for 32.2% of the total 79 species are protected by CITES. There are 15 species listed in Appendix I and 14 in Appendix II of the total 29 species. n Table 3.3-5 and attached figure 11-14 show the rare and endangered mammals in the evaluated areas.

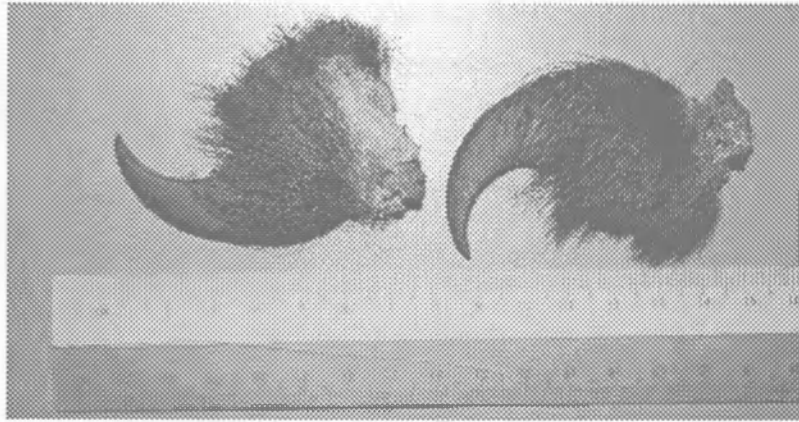
Table 3.3-5 List of distribution status of rare and endangered mammals in evaluated area

Species		Protectio classes		Distribution and quantity						
No.	Scientific names	IUCN Red List	CITES Appendix	Yena n	Kaungla nhpu	Pisa	Wuts ok	Chib we	Laza	Myits one
1	<i>Tupaia belangeri</i>	LC	II	+						
2	<i>Nycticebus bengalensis</i>	VU	I		+					+
3	<i>Macaca leonina</i>	VU	II	+	+				+	
4	<i>M. mulatta</i>	LC	II	+	+					
5	<i>M. assamensis</i>	NT	II	++	++		+++	+++		+++
6	<i>M. arctoides</i>	VU	II	+++	++			++		+
7	<i>Trachypithecus shortridgei</i>	EN	I	++			+++	+++	+++	

**Table 3.3-5 List of distribution status of rare and endangered mammals
in evaluated area**

Species		Protectio classes		Distribution and quantity						
No.	Scientific names	IUCN Red List	CITES Appendix	Yena n	Kaungla nhpu	Pisa	Wuts ok	Chib we	Laza	Myits one
8	<i>Hoolock leuconedys</i>	VU	I	+++	+		+	+++	+	
9	<i>Manis pentadactyla</i>	EN	II		+			++		+
10	<i>M. jakanica</i>	EN	II					++		
11	<i>Cuon alpinus</i>	EN	II					+		
12	<i>Selenarctos thibetanus</i>	VU	I	++	++		+++	+++		
13	<i>Helarctos malayanus</i>	VU	I			+	++	++		
14	<i>Ailurus fulgens</i>	VU	I	+	+	++	+			
15	<i>Lutra lutra</i>	NT	I							+
16	<i>Viverra megaspila</i>	VU								+
17	<i>Arctictis binturong</i>	VU		+						+
18	<i>Prionodon pardicolor</i>	LC	I						++	++
19	<i>Felis chaus</i>	LC	II	+						
20	<i>Catopuma temminckii</i>	NT	I					++		
21	<i>Prionailurus bengalensis</i>	LC	II	+++	+++	++	+++	+++	+++	+++
22	<i>P. viverrina</i>	EN	II					+		+
23	<i>Pardofelis marmorata</i>	VU	I	++			++			
24	<i>Neofelis nebulosa</i>	VU	I				-	-	+	+
25	<i>Moschus berezovskii</i>	EN	II					+		
26	<i>Rusa unicolor</i>	VU					+	+	+++	+++
27	<i>Bos gaurus</i>	VU	I					+		++
28	<i>Budorcas taxicolor</i>	VU	II	+++	+++	++	++			
29	<i>Capricornis milneedwardsii</i>	NT	I	+++	+++	+++	+++	+++		
30	<i>C. rubidus</i>	NT	I	++	+++	+++	+++	+++		
31	<i>Naemorhedus baileyi</i>	VU	I		+					
32	<i>Ratufa bicolor</i>	NT	II	++	++					

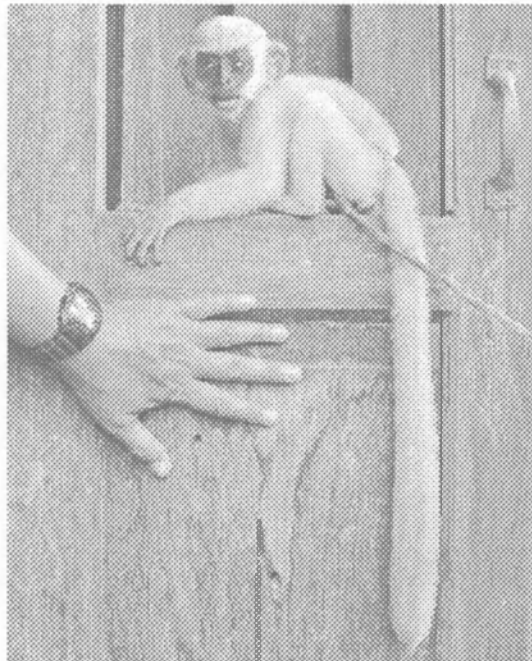
Notes: "-" means it is scarcely recorded, "+" means rare species, "++" means it is sustainable species community and "+++" is common species.



Claws of black bear



Leopard cats



Trachypithecus shortridgei



Dhole

3) Habitats types

Habitats of mammals in the evaluated area mainly include four types: seasonal rainforests, mountain forests, subalpine forests and shrub, wetland and rivers.

① Seasonal rainforests

Under direct influence of wet and warm airflows blown from southwest monsoons from India Ocean, seasonal rainforests are often born on the bottom of valleys, which constitutes the most advanced vegetation community in mountains of northern Myanmar and are mainly distributed from both banks of rivers and streams to mountains with altitudes lower than 600-800m. Because located in a transition zone from mountains of northern Myanmar extending to middle plains, Myitstone region has a flat terrain and wide river valleys, currently is occupied by a large area of habitats of the same kind; This kind of are relatively small in Pisa and Wutsok have relatively small habitats of this kind due to their precipitous terrains; This kind of habitat decreases significantly in Kaunglanhpu and Yenand districts. This kind of habitat is presenting a tendency of gradually decreasing from south to north. Mammals living in this kind of habitat are divided into crown dwelling, ground dwelling, semi-ground dwelling, cave dwelling, valley semi-aquatic dwelling animals.

Crown dwelling animals: Ecological niche of this kind of animals is relatively narrow and has higher requirements toward habitating environment. Representating species in this

habitating type mainly are many endangered species in Lorisidae, e.g. *Nycticebus coucang*, *Hoolock leuconedys* and *Trachypithecus shortridgei*. Additionally, a few species eating meats are also classified into cown dwelling animals like e.g. *Paradoxurus hermaphroditus*, *Arctictis binturong* under Viverridae and a large amount of species under Sciuridae.

Ground or semi-ground dwelling animals: Ecological niche of this kind of animals is relatively wide, except act above ground, they also have a partial dwelling history on the trees, thus their reactions toward habitat environment are not very sensitive. A majority of mammals living in forests are classified into this dwelling type, e.g. *M. mulatta*, *M. assamensis* under Lorisidae; also including a majority of carnassial animals like Ursidae and *Helarctos malayanus*, *Paguma larvata* and *Arctogalida trivirgata* under Viverridae, *Prionodon pardicolor* under Prionodonidae, *Prionailurus bengalensis* and *Pardofelis marmorata* under Felidae. Additionally, animals mainly acting above grounds like *Cuon alpinus* under Canivora, Viverridae and *V. Megaspila* under Viverridae, a majority of Artiodactyla animals and some rodentia animals are classified into ground dwelling or semi-ground dwelling animals.

Cave dwelling animals: This kind of animals are suitable to live underground and have unique habits, easily affected by artificial activities. *Manis* sp. of Pholidota and *Rhizomys* sp. of Rodentia are representating species in this type. Besides, small species of Carnivora, such as *Mustelidae* sp., *Melogale* sp. and most of rodents have the habit of living in cavities.

Valley semi-aquatic dwelling animals: This kind of animals lives in forests on banks of valleys, and largely depend on water. Food sources are fishes, arthropoda animals and soft-bodied animals, e.g. *Herpestes urva* and *P. viverrina*. In addition, some species don't hunt for food from water whereas frequently act along the rivers, e.g. *Rusa unicolor* and *Bos gaurus* under Artiodactyla are also classified into valley semi-aquatic dwelling animals.

② Mountain forests

Mountain forests include monsoon evergreen broad-leaved forests, evergreen deciduous

mixed forests, mixed forests of moso bamboo and broad-leaved forests, and are often distributed in regions at altitude from 800 to 2000m.

Based on differences on ecological habits, wild animals habiting under such environment are divided into four kinds of species. Regarding tree dwelling species, several lorissidae animals are living under this environment; except lorissidae animals mentioned above, ground dwelling and semi-ground dwelling species being good at acting in precipitous mountains at higher altitudes like *C. rubidus* also live here. The distribution status of animals under other two dwelling types is similar with that of monsoon rainforests.

③ Subalpine forests and shrubs

Sub-alpine forests and shrubs are located on mountains at altitude of 2000m above, including evergreen deciduous mixed forests, needle and broad-leaved mixed forests, dark coniferous forests and sub-alpine shrubs, where it is cold and dry and features a large amount of rare species and rich diversity in dwelling creatures.

Because of human activities taking place more frequently in Myitsone region, there is only a small scale of such habitat distributed here; because of situating in mountains and valleys, such ecological environment is widely distributed in other several regions. This kind of habitat in evaluated area tends to gradually increase from south to north. Many rare animals distributed in narrow fields are living here, e.g. Ailuridae, *Moschus berezovskii*, *Budorcas taxicolor*, *N. baileyi* and *C. Rubidus*.

④ Wetlands and rivers

This ecological system is located in a transitional region between lands and waters, and often exists in shape of fresh water lakes, shallow water, meadow and swamps, riverbanks. Animals depending on such ecological system are few. Species recorded in surveyed region this time is relatively few, only *Rusa unicolor* and *Bos gaurus* often act in this region.

(2) Birds

1) Species and quantity

A total number of 455 birds which belonged to 20 orders, 70 families and 210 genera were recorded in the entire watershed areas. There are 296 species accounting for 65.05% of Passeriformes, and 159 species accounting for 34.95% of Non-passeriformes. There are 8 species of summer migrants, 352 species of residents, 70 species of winter migrants and 13 new records of north Myanmar with the proportion of 1.76%, 77.36%, 15.38% and 2.86% respectively. Checklist of birds in the evaluated area is seen in appendix 3.

2) Rare and endangered birds

Of all the 455 bird species being recorded, 17 species are listed in IUCN Red List. Among the 17 species, 10 are listed as Near Threatened including *Anhinga melanogaster*, *Ichthyophaga ichthyaetus*, *Ichthyophaga humilis*, *Buceros bicornis*, *Brachypteryx hyperythra*, *Spelaeornis chocolatinus*, *Arborophila atrogularis*, *Alcedo Hercules*, *Garrulax nuchalis* and *Sphenocichla humei*; 6 are listed as Vulnerable including *Haliaeetus leucoryphus*, *Tragopan blythii*, *Gallinago nemoricola*, *Aceros nipalensis*, *Stachyris oglei* and *Sitta Formosa*; 1 species (*Ardea insignis*) listed as Critically Endangered.

There are 3 species listed in Appendix I including *Falco peregrinus*, *Aceros nipalensis* and *Tragopan blythii*; 8 species listed in Appendix II including *Ciconia nigra*, *Polyplectron bicalcaratum*, *Anthracoceros albirostris*, *Buceros bicornis*, *Leiothrix lutea*, *Leiothrix argentea*, *Acridotheres albocinctus* and *Gracula religiosa* of all the 11 species being recorded. Distributions of rare and endangered birds in the evaluated areas is seen in table 3.3-6 and attached figure 16.

3) Types of habitats

The whole investigation region is divided into 7 areas including Yenam, Khaunglanhpu, Pisa, Wutsok, Chibwe, Laza and Myitsone. Of all the 455 bird species being recorded, 109 species were found in 5 areas, 145 were found in 3 to 4 areas, 203 were found in 2 areas and 107 were only found in 1 area of all the 7 areas with the proportion of 23.96% , 31.87%, 44.62% and 23.52% respectively.

Table 3.3-6 List of distribution status of rare and endangered birds in evaluated area

Species	IUCN Red List	CITES Appendix	Dwelling types	Quantity	Distribution sections (sections)
<i>Ardea insignis</i>	CR		R	2	Laza
<i>Haliaeetus leucoryphus</i>	VU		R	1	Laza
<i>Tragopan blythii</i>	VU	I	R	6	Kaunglanhpu
<i>Gallinago nemoricola</i>	VU		WV	2	Wutsok and Chibwe
<i>Aceros nipalensis</i>	VU	I	R	25	Yenan, Kaunglanhpu, Wutsok , Chibwe , Laza and Myitsone
<i>Stachyris oglei</i>	VU		R	6	Kaunglanhpu
<i>Sitta formosa</i>	VU		R	23	Yenan, Kaunglanhpu, Wutsok and Chibwe
<i>Anhinga melanogaster</i>	NT		WV	4	Myitsone
<i>Ichthyophaga ichthyaetus</i>	NT		R	6	Yenan and Laza
<i>Ichthyophaga humilis</i>	NT		R	2	Kaunglanhpu and Myitsone
<i>Arborophila atrogularis</i>	NT		R	5	Yenan, Pisa and Chibwe
<i>Alcedo hercules</i>	NT		R	3	Yenan, Chibwe and Laza
<i>Buceros bicornis</i>	NT	II	R	38	Yenan, Kaunglanhpu, Wutsok , Chibwe , Laza and Myitsone
<i>Brachypteryx hyperythra</i>	NT		R	1	Chibwe
<i>Spelaornis chocolatinus</i>	NT		R	5	Kaunglanhpu, Wutsok and Chibwe
<i>Sphenocichla humei</i>	NT		R	7	Kaunglanhpu, Wutsok and Chibwe
<i>Garrulax nuchalis</i>	NT		R	79	Yenan, Kaunglanhpu, Chibwe , Laza and Myitsone
<i>Ciconia nigra</i>		II	WV	10	Wutsok , Chibwe and Laza
<i>Polyplectron bicalcaratum</i>		II	R	28	Yenan, Wutsok , Chibwe , Laza and Myitsone
<i>Anthracoceros albirostris</i>		II	R	24	Laza and Myitsone
<i>Leiothrix lutea</i>		II	R	27	Yenan, Kaunglanhpu, Chibwe
<i>Leiothrix argentea</i>		II	R	516	Yenan, Kaunglanhpu, Wutsok , Chibwe , Myitsone
<i>Acridotheres albocinctus</i>		II	R	354	Laza , Myitsone
<i>Gracula religiosa</i>		II	R	57	Chibwe , Laza , Myitsone
<i>Falco peregrinus</i>		I	WV	9	Chibwe , Laza , Myitsone

Note: "R" means resident birds , "WV" means winter visitors.

Through observing the results of this survey, species occurring in single region are mainly distributed in Myitsone region, followed by Chibwe and Kaunglanhpu regions, few in Laza and Yanan, none in Pisa and Wutsok, seen in figure 3.3-2. From the perspective of survey

time, it is analyzed that the reasons why a lot of species in single region are seen in Myitson include long survey time and a large span with respect to this region; from perspective of ecological environment, Kaunglanhpu region is represented by virgin forests with high altitudes. Chibwe region is represented by virgin forests and secondary forests with medium and low altitudes. Myitsone region is represented by secondary forests with low altitude; Through analyzing from perspective of water sources within the region, Kaunglanhpu is a source region, Chibwe is one with various branches converged into and Myitsone is in lower stream of confluence between Malikha River and Nmai Kha River.

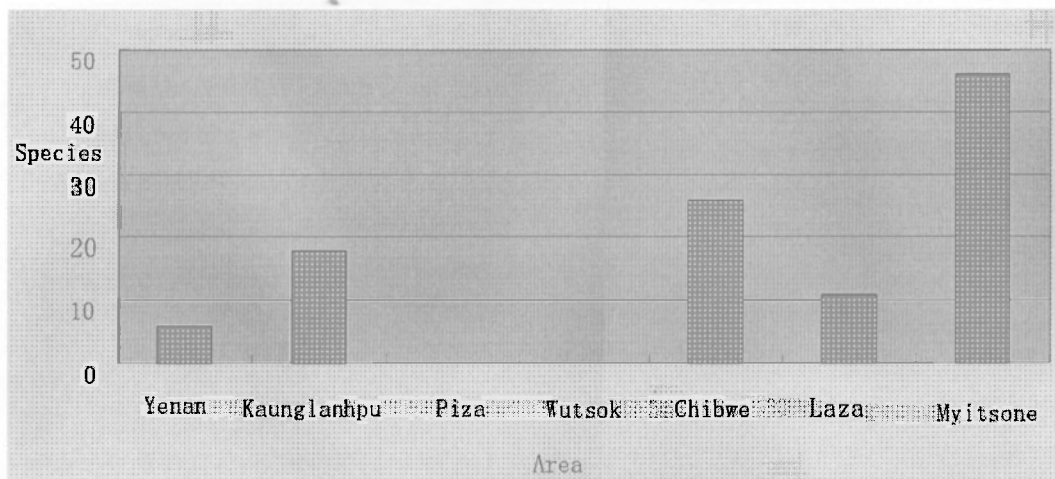


Figure3.3-2 Distributions of single-region species

Birds habitats in the evaluated areas are divided into 5 types:

① Rivers and waters

River ecological system presents a uniform phenonemon of distributing like strips in verticial direction. Verticial alternation of species doesn't evenly and continuously change. Special species occur again in the whole rivers like *Phalacrocorax carbo*; Birds acting in this district are mostly those that have special morpholigical structures suitable to ecological environments under rapid rivers, for example, several kinds of dovetails act in Nmai Kha River at the confluence of two rivers.

Goose and duck species are mainly distributed in lower stream of confluences between two rivers, and sparsely distributed in upper stream. *Larus ichthyaetus* and *Larus*

brunnicephalus often act in rivers. Ciconiiformes species and *Anhinga melanogaster* prefer habiting on tranquil and smooth river surface. *Alcedo atthis* and *Megaceryle lugubris* often habit in twigs or stone edges nearby rivers. *Charadrius dubius* like habiting in river beaches and pebble beaches. *Rhyacornis fuliginosus* prefer living in regions along the banks of rivers with a large amount of loose stones.

② Wetlands

Wetland is transitional zone between lands and waters and equipped with rich resources related to land and aquatic animal and plants. *Amaurornis phoenicurus* often hunt for foods in streams and rivers on banks of this watershed, farmlands and wetlands. Birds under Ardeidae mostly habit in wetlands and forest areas nearby waters. Birds under Motacillidae frequently occur in wetlands of farmlands and along banks of rivers. Shorebirds often hunt for food in wetland environment along rivers. Dovetails mainly choose wet environment of streams storing water as its habitate.

③ Ecological environment of shrub grasslands

Shrub grassland refers to a plant community where mesophytic or xerophytic mesophytic perennial herbaceous plants are taken as dominant species with a sparse distribution of shrubs. Shrub grassland in evaluated area is mainly distributed on both banks along rivers and nearby villages and farmlands. Campephagidae, Emberizidae, Sylviidae and *Hypsipetes leucocephalus* under Passeriformes often choose shrub grasslands as their habiting environment, mainly living in middle and lower part of open forests on mountain feet and shrubs; Birds under Cuculiformes often habitate on top of high shrub forests.

④ Villages – farmlands ecological system

Land resources from Myitkyina extending to Myitsone sections are relatively distributed evenly and suitable for settled agricultures, villages often develop toward even distribution; hills and mountainous areas cover a large area in north of Myitsone, and villages mostly are centralized valleys, mountain feet and edges of mountain feet. Birds depending on this ecological system mainly include crow, *Passer montanus*, *Psittacula finschii* and birds

under Sturnidae.

⑤ Mountainous secondary forests

Secondary forests refer to those that are naturally formed after virgin forests lose original forest environments due to unreasonable cutting, deforestation, fire disaster and shifting cultivation activities and are replaced by various secondary communities. Mountainous secondary forests in evaluated area are mostly young and middle-aged forests, often taking broad-leaved species as dominant species. Birds under Falconiformes often choose mountainous secondary forests as their habitats, frequently seen in mountains, plains, mountain feet and hilly lands.

(3) Reptiles

1) Species

A total number of 69 species which belonged to 3 orders, 14 families and 46 genera were recorded in the investigation with 57 species identified and 12 only identified to genus. Megapodiidae is superior in numbers with 29 species accounting for 42.03% of the total reptiles. There are 39 species of reptiles being recorded which belong to 3 orders, 13 families and 31 genera in Myitsone region; 25 species belong to 3 orders, 9 families and 21 genera in Laza region; 13 species belong to 2 orders, 5 families and 13 genera in Chibwe region; 13 species belong to 2 orders, 4 families and 12 genera in Wutsok region; 8 species belong to 2 orders, 4 families and 8 genera in Pisa region; 13 species belong to 2 orders, 4 families and 10 genera in Kaunglanhpu region and 13 species belong to 2 orders, 5 families and 11 genera in Yenau. Checklist of reptiles in the evaluated areas is seen in appendix 3.

2) Rare and endangered reptiles

Of 57 species being identified, there are 3 species listed as Endangered including *Kachuga trivittata*, *Pyxidea mouhotii* and *Indotestudo elongate*, 1 species (*Heosemys grandis*) listed as Vulnerable, and 3 species listed as Near endangered including *Melanochelys trijuga*, *Python molurus* and *Cyclemys dentate* in IUCN Red List. *Python*

molurus is listed in Appendix I, 6 are listed in Appendix II including *Kachuga trivittata*, *Indotestudo elongate*, *Varanus salvator*, *Varanus dumerillii*, *Naja kaouthia* and *Ophiophagus Hannah* and 1 species (*Xenochrophis piscator*) listed in Appendix III of CITES. Checklist of rare and endangered reptiles in the evaluated area is seen in table 3.3-7 and attached figure 15.

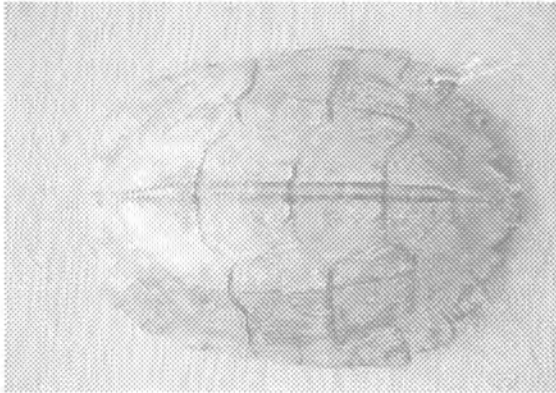
Table 3.3-7 List of rare and endangered reptile animals in evaluated area

No.	Species	IUCN Red List	CITES Appendix	Habitat environment	Ecological types	Distribution sections (sections)	Altitude elevation (m)	Resource quantity
1	<i>Python molurus</i>	NT	I	3,4	TR,TQ	Myitsone,Laza ,Pisa	200-700	++
2	<i>Naja kaouthia</i>		II	1,2,3,4	TR	Myitsone,Laza , Chibwe ,Wutsok ,Pisa	100-1000	+++
3	<i>Ophiophagus Hannah</i>		II	2,3,4	T	Myitsone, Chibwe , Kaunglanhpu,Pisa	150-1000	++
4	<i>Xenochrophis piscator</i>		III	2,3,4	TR	Myitsone	100-400	+++
5	<i>Varanus dumerillii</i>		II	2,,4	TR	Myitsone	200-450	+
6	<i>Varanus salvator</i>		II	2,3,4	TR	Myitsone,Laza	200-450	++
7	<i>Kachuga trivittata</i>	EN	II	1,3	R	Myitsone	100-300	+
8	<i>Pyxidea mouhotii</i>	EN		3,,4	R	Myitsone,Laza ,Yenan	150-500	++
9	<i>Indotestudo elongate</i>	EN	II	4	T	Myitsone	300-600	+
10	<i>Melanochelys trijuga</i>	NT		3	T	Myitsone,Laza	250-700	+
11	<i>Heosemys grandis</i>	VU		1,2	W	Laza	100-300	+
12	<i>Cyclemys dentata</i>	NT		3	R	Laza	200-500	++

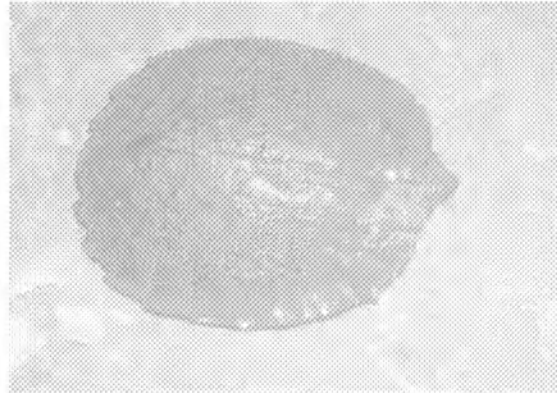
Note: Habitat environment: 1-Large rivers and river banks zones 2-Residences, farmlands and main roads zone 3-Small branches, creeks and spring zone 4- mountain slopes and forests zone

Ecological types: T- Terrestrial type W-Aquatic dwelling type R-Flowing water type TQ-Terrestrial—stagnant water type TR-Terrestrial-flowing water type

Resource quantity: “+” means rare species. “++” means common species. “+++” means dominant species.



Pyxidea mouhotii



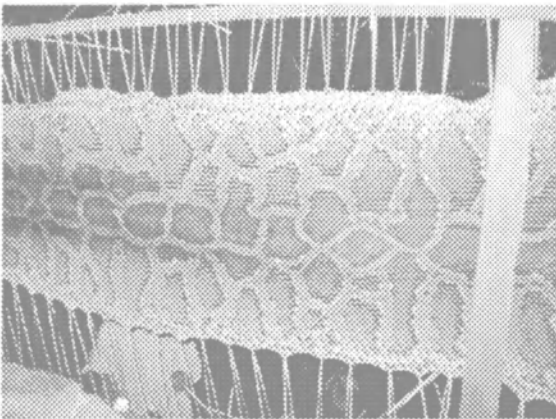
Cyclemys dentata



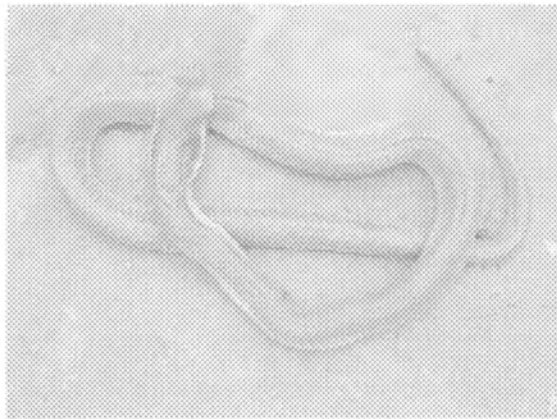
Varanus salvator



Naja Kaouthia



Python molurus



Naja kaouthia

3) Habitat types

The evaluated area is covered by thick mountainous forests with rivers and creeks criss-crossing the landscape, diverse types of ecological environments and abundant foods that are beneficial to growth and proliferation of reptiles. Reptiles in the evaluated

area are mainly distributed into 4 zones described as follows.

① Large rivers and river banks areas

Large river and river banks zone mainly includes regions and regions along the banks affected largely by flows from Ayarwaddy River, Malikha River and Nmai Kha River, where *Heosemys grandis* and *Kachuga trivittata* under Testudoformes, *Sphenomorphus maculatus*, *Calotes versicolor* and *Calotes mystaceus* under Lacertiformes are dwelling, furthermore, *Rhabdophis subminiata*, *Ptyas korros* and *Sinonatrix aequifasciata* under Serpentiiformes are the species with strong adapting abilities.

② Residential district, farmlands and main roads areas

Residential district, farmlands, main roads, orchards and grasslands etc. are disturbed more than other areas. Reptiles are more numerous in this region including *Calotes versicolor*, *Calotes mystaceus*, *Hemidactylus bowringii*, *Hemidactylus frenatus*, *Hemidactylus garnotii*, *Gekko gecko* and *Draco maculatus* etc. of Lecertifromes, *Ptyas korros*, *Rhabdophis subminiata*, *Xenopeltis unicolor*, *Typhlops diardi*, *Naja Kaouthia* etc. of Serpentiiformes.

③ Small branches, creeks and spring areas

Small braches, creeks and spring zone refers to small rivers, creeks and springs excluding Ayarwaddy River, Malikha River and Nmai Kha River. Species and quantities of reptiles in this zone are relatively large. Except *Hemidactylus bowringii*, *Hemidactylus frenatus*, *Hemidactylus garnotii* which are adapted to living in residential district, a lot of other species are able to be found in this zone.

④ Hillsides, Forested areas

This region is far from waters, but have thick forest and shrubs. Temperature and humidity change at high altitudes. Reptiles found here include *Calotes versicolor*, *Gekko gecko*, *Lygosoma indicum* and *Draco maculatus* of Lecertifromes, *Indotestudo elongate* of Chelonia, *Python molurus*, *Ptyas korros*, *Rhabdophis subminiata*, *Naja Kaouthia* and *Ophiophagus hannah* etc. of Serpentiiformes. These species are hard to find because of good hidden conditions.

(4) Amphibians

1) Species

A total number of 46 species which belonged to 3 orders, 8 families and 21 genera were recorded in the investigation with 30 species identified and 16 only indentified to genus. Rhacophoridae and Ranidae are superior in numbers with 15 and 14 species respectively accounting for 63.04% of the total amphibians. There are 20 species being recorded which belong to 2 orders, 6 families and 15 genera in Myitsone region; 10 species belong to 2 orders, 5 families and 9 genera in Laza region; 14 species belong to 1 orders, 4 families and 11 genera in Chibwe region; 13 species belong to 1 orders, 5 families and 10 genera in Wutsok area; 6 species belong to 1 orders, 4 families and 6 genera in Pisa region; 11 species belong to 1 orders, 4 families and 8 genera in Kaunglanhpu region; 11 species belong to 1 orders, 3 families and 8 genera in Yen-an region. Checklist of amphibians in the evaluated area is seen in appendix 3.

2) Rare and endangered amphibians

Of 30 species being identified, *Rana hexadactyla* is listed in Appendix II of CITES and *Polypedates gongshanensis* is listed as Near endangered in IUCN Red List. Checklist of rare and endangered amphibians in the evaluated area is seen in table 3.3-8 and attached figure 16.

Table 3.3-8 List of rare and endangered amphibian animals in evaluated area

No.	Species	IUCN Red List	CITES Appendix	Habitat environments	Ecological types	Distribution sections (sections)	Altitude elevation (m)	Resource quantity
1	<i>Rana hexadactyla</i>		II	3	TR	Chibwe	300-600	+
2	<i>Polypedates gongshanensis</i>	NT		3,4	TR,TQ	Kaunglanhpu	600-800	+

Note: Ecological environment: 1- Large rivers and river banks zone 2-Residences, farmlands and main roads zone 3- Small branches, creeks and spring zone 4- Mountain slopes and forests zone

Ecological types: T- Terrestrial type W-Aquatic dwelling type R-Flowing water type TQ-Terrestrial—stagnant water type TR-Terrestrial-flowing water type

Resource quantity: “+” means rare species. “++” means common species. “+++” means dominant species.

3) Habitat types

Amphibian animals in evaluated area are mainly distributed in the following 4 zones.

① Large rivers and river banks zone

Large river and river banks zone mainly includes regions and regions along the banks affected largely by flows from Ayarwaddy River, Malikha River and Nmai Kha River. Species of amphibians in this zone are few; mainly include *Rana limnocharis*, *Bufo melanostictus*, *Odorrana rotodora* and *Microhyla ornate* with strong adapt abilities.

② Residences, farmlands and main roads zone

Residences, farmlands and main roads zone refers to dwellings, farmlands, vegetable lands, grass lands and main roads that are disturbed largely by human activities. Species of amphibian animals in this zone are few; mainly include *Rana limnocharis*, *Bufo melanostictus*, *Microhyla ornate* and *Limnonectes kuhlii*.

③ Small branches, creeks and spring zone

Small braches, creeks and spring zone refers to small rivers, creeks and springs excluding Ayarwaddy River, Malikha River and Nmai Kha River, where amphibians are mostly concentrated with species and quantities far exceeding other zones. All amphibians in the evaluated area are discovered in this zone.

④ Mountain slopes and forests zone

This zone is covered by dense forests and shrubs, keeps far away from waters, whereas has a big change in regional temperature and humidity at higher altitude. Amphibians distributed in this zone mainly include *Rana limnocharis*, *Bufo melanostictus*, *Microhyla ornate* and *Microhyla heymonsi*.

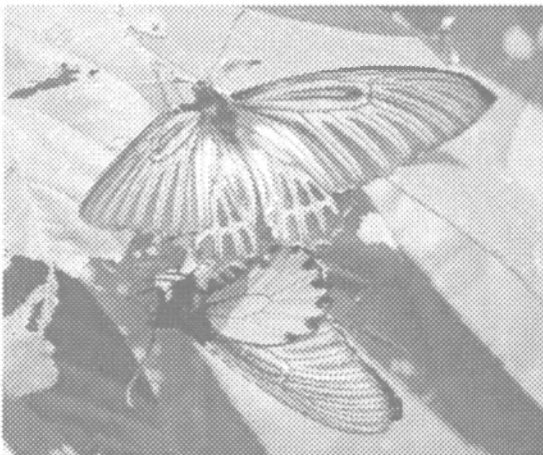
(5) Butterfly

1) Species and quantities

A total number of 2300 butterfly specimens were collected in Chibwe, Myitsone, Yenam, KhaungLanhpu, Laza, Wutsok and Pisa between Malinka River and Enmaynua River. 307 species belong to 11 families and 140 genera were recorded. Among them, Nymphalidae

has the largest number (87 species) with the proportion of 28.34%. There are 1 species of Acraeidae and 2 species of Libytheidae, both of which have the smallest number in the total species. Checklist of butterflies in the evaluated areas is seen in appendix 3.

Both of *Troides aeacus* and *Troides Helena* are listed in Appendix II of CITES. *Troides aeacus* is distributed mainly in Chibwe and Wutsok, and *Troides Helena* is distributed in Chibwe, Wutsok and Pisa. Rare and endangered butterflies in the evaluated area are seen in attached figure 17.



Troides aeacus



Troides helena

2) Features of distribution regions

Butterflies elements are different in dissimilar regions. According to results of butterfly resources system clusters, butterfly resources in watersheds of both rivers are divided into three categories: Chibwe and Wutsok have the same category. Myitsone and Laza have the same category. Yen-an, Kaunglanhpu and Pisa have the same category. More than 10 species of butterflies are shared by 7 regions like *Graphium sarpedon*, *Papilio protenor*, *Appias lalage* and *Lethe verma*.

3.3.2 Aquatic organisms

This aquatic life investigation mainly covers phytoplankton, zooplankton, zoobenthos, periphyton algae and fish, totally 68 sections set. See Figure 3.3-3 for details. According to habitat characteristics at the upper reaches of Ayeyawady River, the upper reachers are

divided into 4 sections in terms of aquatic life, namely, middle and upper reaches of Nmaiha River, lower reaches of Nmaiha River, middle and lower reaches of Malikha River and upper reaches of Ayeyawady River.

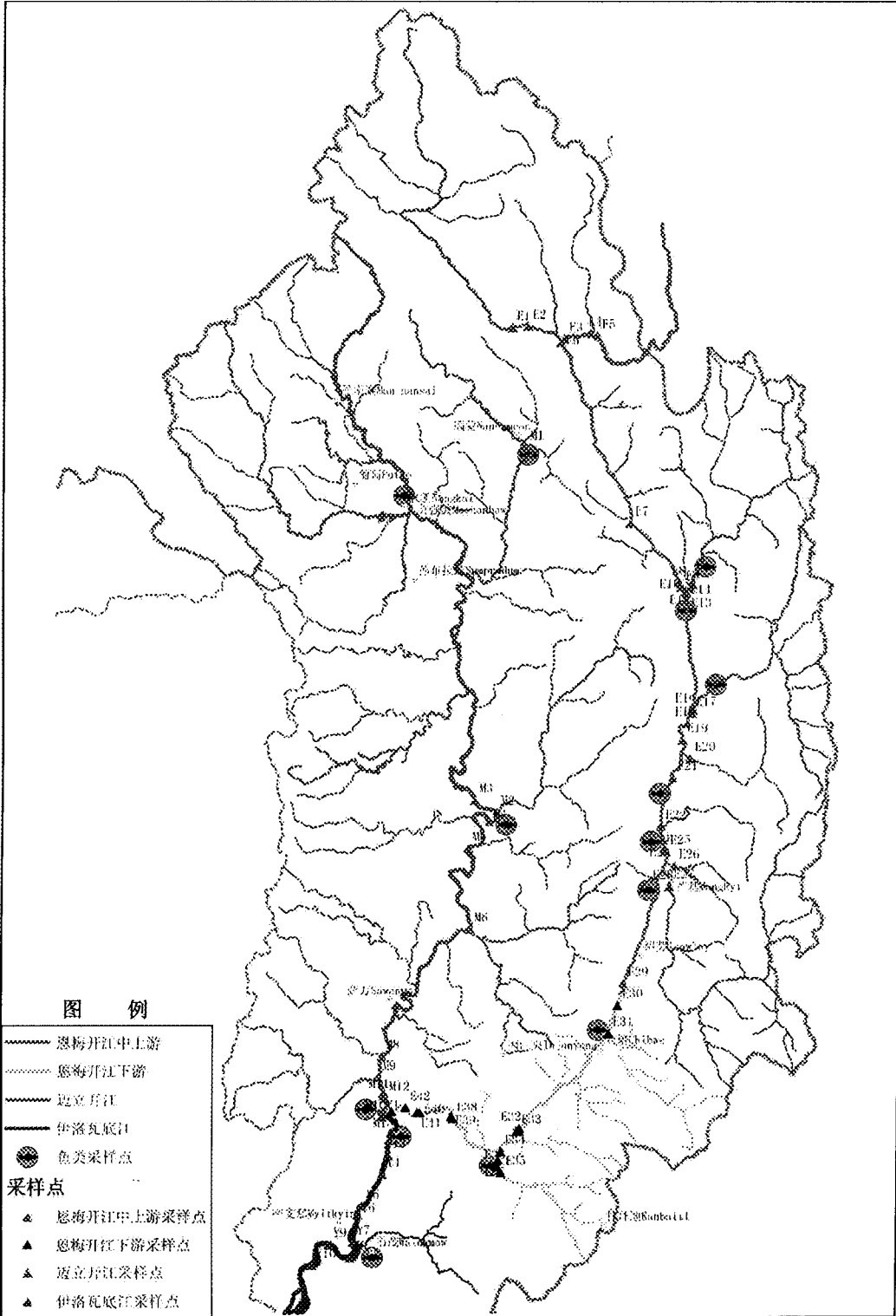


Figure 3.3-3 Schematic diagram of investigation sections of aquatic life

3.3.2.1 Phytoplankton

Totally 293 species of Phytoplankton are collected in the whole surveyed waters (including variety and variant), which are subordinated to 76 genera and 7 phylums, with specific list seen in appendix 5. Bacillariophyta absolutely takes up a dominant position with 221 species and 34 genera (including variety and variant), accounting for 75.4% of total species; There are 30 species and 16 genera under Cyanophyta, 33 species and 20 genera under Chlorophyta, and totally 9 species and 6 genera under other four Phylums.

(1) Species composition of Phytoplankton

1) Middle and upstream of Maykha River

Totally 102 species, 35 genera and 3 phylums of Phytoplankton are identified in such surveyed waters, among which, there are 82 species under Bacillariophyta, accounting for 80.4% of total species, 6 species under Chlorophyta and 14 species under Cyanophyta. Common species include *Diatoma mesodon*, *Fragilaria arcus*, *Cymbella minuta*, *Achnanthes minutissima*, *Achnanthes biasoletiana*, *Achnanthes biasoletiana* var. *subatomus*, *Navicula radiosafallax*, *Gomphonema minutum*, *Gomphonema pumilum*, etc.

2) Downstream of Maykha River

Totally 115 species, 50 genera and 4 phylums of Phytoplankton are identified in such surveyed waters, among which, there are 94 species under Bacillariophyta, accounting for 81.7% of total species, 11 species under Chlorophyta, 9 species under Cyanophyta and 1 species under Cryptophyta. Common species include *Fragilaria biceps*, *Achnanthes biasoletiana*, *Achnanthes biasoletiana* var. *subatomus*, *Navicula radiosafallax*, *Navicula capitatoradiata*, *Gomphonema minutum*, *Gomphonema pumilum* etc.

3) Middle and downstream of Malikha River

Totally 161 species, 35 genera and 3 phylums are identified in such surveyed waters, among which, there are 129 species under Bacillariophyta, accounting for 80.1% of total species; 16 species under Chlorophyta; 16 species under Cyanophyta. Phytoplankton in

such surveyed waters takes Bacillariophyta as primary, followed by Chlorophyta and Cyanophyta. Common species include *Melosira varians*, *Diatoma mesodon*, *Fragilaria arcus*, *Cymbella minuta*, *Achnanthes minutissima*, *Achnanthes biasoletiana*, *Navicula radiosafallax*, *Gomphonema minutum*, *Gomphonema pumilum* etc.

4) Upper stream of Ayarwaddy River

Totally 152 species, 48 genera and 7 phylums are identified in such surveyed waters, among which, there are 119 species under Bacillariophyta, accounting for 78.3% of total species, 14 species under Chlorophyta and 10 species under Cyanophyta, and 9 species under other genera. Phytoplankton in such surveyed waters is dominated by Bacillariophyta, followed by Chlorophyta and Cyanophyta. Other species are occasionally seen. Common species include *Melosira varians*, *Achnanthes biasoletti*, *Fragilaria biceps*, *Navicula radiosafallax* and *Gomphonema parvulum*.

(2) Density of Phytoplankton

1) Middle and upper stream of Maykha River

In such surveyed waters, density of Phytoplankton changes between $0.57 \sim 9.62 \times 10^5$ cells/L, and average density is 3.88×10^5 cells/L. Viewing from its composition abundance of Phytoplankton, diatom occupies absolute advantages in each cross section, and diatom proportion changes between 65.9 ~ 100%.

2) Downstream of Maykha River

In such surveyed waters, density of Phytoplankton changes between $1.21 \sim 11.78 \times 10^5$ cells/L and average density is 4.01×10^5 cells/L. Viewing from its composition abundance, diatom occupies absolute advantages in each cross section, and diatom proportion changes between 88.1 ~ 100%.

3) Middle and lower stream of Malikha River

In such surveyed waters, density of Phytoplankton changes between $1.11 \sim 16.93 \times 10^5$ cells/L and average density is 6.12×10^5 cells/L. Viewing from its composition

abundance, diatom occupies absolute advantages in each cross section, and diatom proportion changes between 91.90 ~ 100%.

4) Upper stream of Ayarwaddy River

In such surveyed waters, density of Phytoplankton changes between 0.12 ~ 32.42×10^5 cells/L and average density is 6.52×10^5 cells/L. Viewing from its composition abundance, diatom occupies absolute advantages in each cross section, and diatom proportion changes between 68 ~ 100%.

(3) Comprehensive analysis on current status of Phytoplankton

In this survey, it is observed that Ayarwaddy Watershed has very abundant species related to Phytoplankton as much as 293 species, among which, Bacillariophyta takes up absolute advantages with 221 species and 34 genera, accounting for 75.4% of total species.

According to the number of species in 4 regions mentioned above, they are ordered as: middle and lower stream of Malikha River > upper stream of Ayarwaddy River > downstream of Maykha River > middle and upper stream of Maykha River with 161 species, 152 species, 115 species and 102 species respectively; through observing average densities of 4 regions mentioned above, they are ordered as : upperstream of Ayarwaddy River > middle and downstream of Malikha River > downstream of Maykha River > middle and upper stream of Maykha River being 6.52×10^5 cells/L, 6.12×10^5 cells/L, 4.01×10^5 cells/L and 3.88×10^5 cells/L respectively. Species and average densities in 4 regions are listed in figure 3.3-3 and figure 3.3 ~ 4.

Number of species and average densities in middle and downstream of Malikha River are close to those in upperstream of Ayarwaddy River; number of species and average densities in downstream of Maykha River are close to those in middle and downstream of Maykha River. Differences in species number of Phytoplankton may be related to environmental features in each region. Comparatively speaking, terrains in middle and downstream of Malikha River and upperstream of Ayarwaddy River are flat and open with water flowing slowly, human activities taking place frequently and rich nutritions, thus

species of Phytoplankton are huge and the biomass is very high; Maykha River has a big drop height, with water flowing rapidly and scarce human activities and lacks of nutritions, thus species of Phytoplankton are few and the biomass is low.

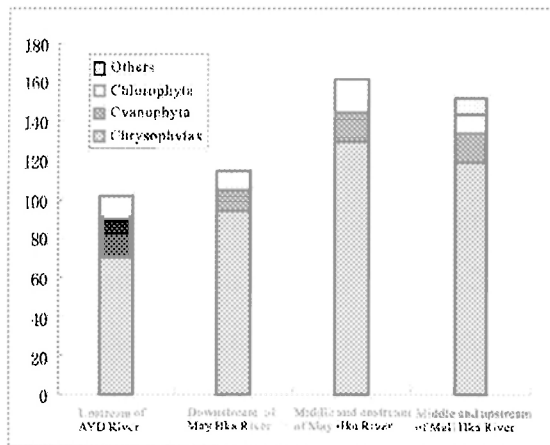


Figure 3.3-3 Comparison lists of species in 4 surveyed regions

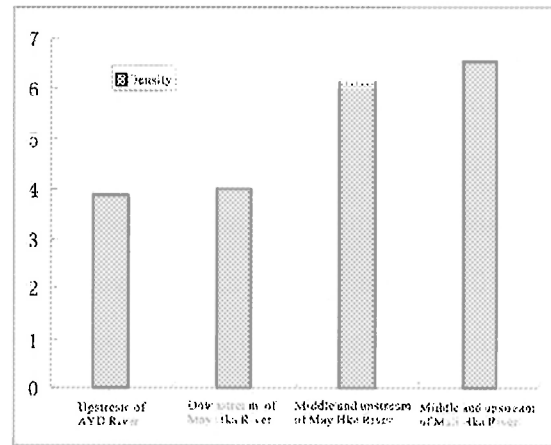


Figure 3.3-4 Comparison lists of densities in 4 surveyed regions

3.3.2.2 Zooplankton

Totally 199 species (genera), 92 genera, 56 families, 20 orders, 8 classes and 4 phylums of Zooplankton are collected in this survey with specific lists seen in appendix 6, among which, there are 117 species of Protozoa accounting for 58.79% of total species; 57 species of Rotifer accounting for 28.64% of total species; 9 species under Cladocera accounting for 4.52% of total species; 16 species under Copepoda accounting for 8.04% of total species.

(1) Species compositions of Zooplankton

1) Middle and upper stream of Maykha River

Totally 92 species of Zooplankton are collected, among which, there are 67 species, 29 genera, 20 families, 11 orders, 5 classes and 2 phylums under Protozoa, accounting for 72.8% of total species. Common species under Sarcodina are *Cyclopyxis deflandrei*, *Wailesella* sp., *Centropyxis aculeata*, *Centropyxis discoides*, *Quadrullella symmetrica* and *Diffflugia globulosa*; there are 25 species, 15 genera, 12 families, 2 orders, 2 classes and 1 phylums under Rotifer. *Lepadella patella*, *Philodina* sp., *Cephalodella gibba* and

Habrotrocha sp. are common species; Species under Cladocera and Copepoda are not identified through verification.

2) Downstream of Maykha River

Totally 83 species of Zooplankton are collected, among which, there are 52 species, 26 genera, 18 families, 10 orders, 4 classes and 2 phylums under Protozoa, accounting for 62.65% of total species. Common species are *Centropyxis discoides*, *Arcella hemisphaerica*, *Centropyxis aculeata* and *Quadrulella symmetrica*; There are 29 species, 16 genera, 10 families, 2 orders, 2 classes under Rotifer. Common species are *Cephalodella gibba*, *Cephalodella innesi*, *Philodina* sp. and *Lepadella patella*; 1 species, 1 genera and 1 family is discovered under Cladocera and 1 species, 1 genera and 1 family under Copepoda.

3) Middle and downstream of Malikha River

Totally 90 species of Zooplankton are collected, among which, there are 57 species, 29 genera, 19 families, 11 orders, 5 classes and 2 phylums under Protozoa, accounting for 63.3% of total species. *Centropyxis discoides*, *Quadrulella symmetrica*, *Centropyxis aculeata* and *Wailesella* sp. are common species; There are 23 species, 15 genera, 12 families, 3 orders, 2 classes under Rotifer. Common species are *Lecane closterocerca*, *Lecane crenata* and *Philodina* sp.; there are only 4 species, 2 genera, 2 families under Cladocera and 6 species, 5 genera and 2 families under Copepoda.

4) Upper stream of Ayarwaddy River

Totally 96 species of Zooplankton are collected, among which, there are 55 species, 29 genera, 18 families, 12 orders, 4 classes and 2 phylums under Protozoa, accounting for 57.29 % of total species, constitutes one group with most abundant species. Common species under Protozoa are *Diffugia globulosa*, *Centropyxis aculeata*, *Centropyxis discoides* and *Arcella hemisphaerica*; There are 21 species, 14 genera, 12 families, 2 orders, 2 classes under Rotifer, accounting for 21.88 % of total species. *Colurella unicauda*, *Keratella cochleari*, *Lepadella patella* and *Pompholyx sulcata* are common species; There

are 8 species, 5 genera and 4 families under Cladocera , accounting for 8.9% of total species. There are 12 species, 8 genera and 3 families under Copepoda accounting for 13.3% of total species. There are 3 species under *Bosmina* and *Thermocyclops*. Species under other orders are relatively few.

(2) Density and Biomass of Zooplankton

1) Middle and upper stream of Maykha River

Density of Zooplankton in upper stream of surveyed Ayarwaddy River changes from being not identified to 930 ind./L, and average density is 406.4 ind./L. Biomass changes from being not identified to 35.15µg/L and average value is 7.01µg/L.

2) Downstream of Maykha River

Density of Zooplankton in downstream of Maykha River changes between 15 ~ 1500 ind./L and average density is 427.2 ind./L. Biomass changes between 1.13 ~ 32.78µg/L and average value is 10µg/L.

3) Middle and downstream of Malikha River

Density of Zooplankton in downstream of surveyed Malikha River changes between 15 ~ 2805 ind./L, and average density is 768.1 ind./L. Biomass changes between 0.45 ~ 60.98µg/L and average value is 13.71µg/L.

4) Upper stream of Ayarwaddy River

Density of Zooplankton in upper stream of Ayarwaddy River changes from not being identified to 2475 ind. /L and average density is 943.6 ind./L. Biomass changes from not being identified to 81.1µg/L and average density is 31.14µg/L.

(3) Comprehensive analysis on current status of Zooplankton

Through this survey, it is discovered that species of Zooplankton are abundant in Ayarwaddy Watershed as much as 199 species (genera), which are mainly composed of Protozoa and Rotifer. Protozoa is dominant group accounting for 58.79% of total species,

followed by Rotifer, which accounts for 28.64% of total speices. Large species of Cladocera and Copepoda are scarcely found.

Through the number of species in 4 regions mentioned above, they are ordered as: upper stream of Ayarwaddy River> middle and upper stream of Maykha River> middle and downstream of Malikha River >downstream of Maykha River with 96 species, 92 species, 90 species and 83 species respectively. The differences on species number of Zooplankton are slightly in 4 regions. Through standing crop in 4 regions, they are ordered as: upper stream of Ayarwaddy River> middle and downstream of Malikha River >downstream of Maykha River>middle and upper stream of Maykha River with average density of Zooplankton as 943.6 ind./L, 768.1 ind./L, 427.2 ind./L and 406.4 ind./L respectively. Speices and average densities in 4 regions are seen in figure 3.3-5 and figure 3.3-6.

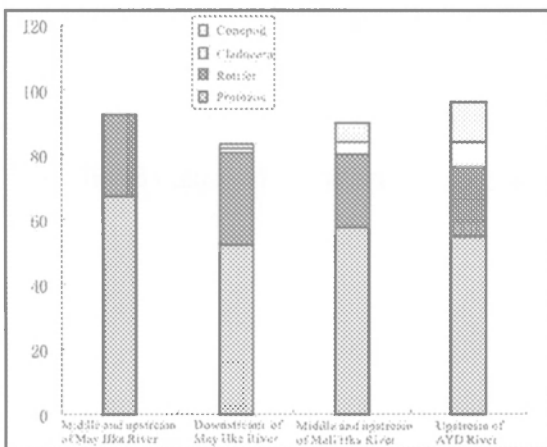


Figure 3.3-5 Comparison lists of species in 4 surveyed regions

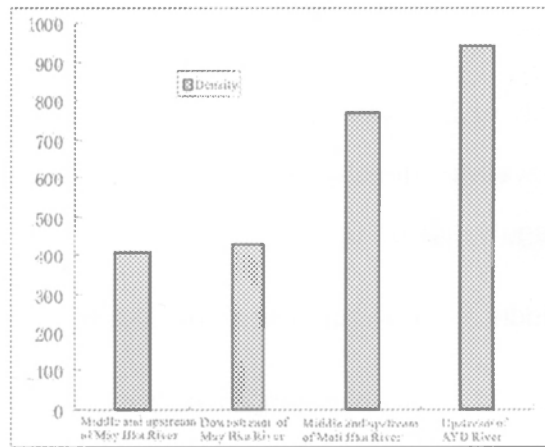


Figure 3.3-6 Comparison lists of densities in 4 surveyed regions

Because upper stream of Ayarwaddy River is located in confluence between Maykha River and Malikha River, with the Zooplankton from both rivers converging into, furthermore, upper stream of Ayarwaddy River has a concentrated population, where human activities take place frequently, thus this section has abundant nutritions that are beneficial to growth of Zooplankton, leading to species and average density of plankton species are richer than those in other 3 regions. However, the average density of Zooplankton in Maykha River is relatively smaller, possibly because Maykha River situates in mountainious areas at higher altitude, with sparse population and waters flowing at rapid speed.

Standing crop of Zooplankton in whole surveyed region are mainly dominated by small Protozoa and Rotifer. Large Zooplankton like Cladocera and Copepoda are only identified in upper stream of Ayarwaddy River whereas occupies small proportion. Cladocera and Copepoda are not discovered in Maykha River and Malikha River, indicating biomass of Zooplankton in the whole surveyed region is relatively lower.

3.3.2.3 Zoobenthos

Totally 139 species (genera or family), 61 genera, 62 families, 11 orders, 4 classes and 3 phyla of Zoobenthos are collected in this survey with specific list seen in appendix 7. There are 127 species of aquatic insects accounting for 91.37%; 8 species under Oligochaete accounting for 5.76%; 1 species under Crustacea accounting for 0.72%, and 3 species under other orders accounting for 2.16%.

(1) Species of Zoobenthos

1) Middle and upper stream of Maykha River

Totally 85 species (genera or family), 41 genera, 8 orders, 4 classes and 3 phyla of Zoobenthos are collected in this survey. There are 78 species under aquatic insects accounting for 91.76% of total species, 5 species under Oligochaete accounting for 5.88% and 2 species under other orders, accounting for 2.35%. Common species are Perlidae sp (Plecoptera), *Cinygmula* sp (Heptageniidae/Ephemeroptera), *Baetis* sp and *Pseudocloeon* sp (Baetidae), *Ceratopsyche* sp (Hydropsychidae), *Elmidae* sp and *Scirtidae* sp (Coleoptera), *Polypedilum* sp and *Thienemannimyia* sp (Chironomidae).

2) Downstream of Maykha River

Totally 71 species (genera or family), 37 genera, 9 orders, 3 classes and 3 phyla of Zoobenthos are collected in this survey. There are 66 species of aquatic insects accounting for 92.96% of total species; 4 species under Oligochaete accounting for 5.63%, 1 thread worm, accounting for 1.41%. Common species are Perlidae sp (Plecoptera), *Cinygmula* sp (Heptageniidae/Ephemeroptera), *Baetis* sp (Baetidae), *Limnophila* sp (Tipulidae/Diptera).

3) Middle and downstream of Malikha River

Totally 30 species (genera or family), 18 genera, 9 families, 3 classes and 2 phylums are collected in this survey. There are 28 species of aquatic insects accounting for 93.33% of total species, 1 species under Oligochaete and Tcrustacean accounting for 3.33% respectively. Common species are baetidae.

4) Upper stream of Ayarwaddy River

Totally 59 species (genera or family), 34 genera, 7 families, 3 classes and 3 phylums are collected in this survey. There are 56 species of aquatic insects accounting for 94.92% of total species; 2 species under Oligochaete accounting for 3.39%; 1 thread worm for 1.70%. Common species are *Baetis* sp (Baetidae) and *Polypedilum* sp (Chironomidae).

(2) Density and Biomass of Zoobenthos

1) Middle and upper stream of Maykha River

Density of Zoobenthos in upper stream of surveyed Ayarwaddy River changes between 0 ~ 977.78ind./m², and average density is 339.39ind./m². Biomass changes between 0 ~ 24.0527g/m² and average value is 2.7708g/m².

2) Downstream of Maykha River

Density of Zoobenthos in downstream of surveyed Maykha River changes between 0 ~ 3574.60ind./m² and average density is 578.90ind./m². Biomass changes between 0 ~ 19.9625g/m² and average value is 4.2117g/m².

3) Middle and downstream of Malikha River

Density of Zoobenthos in middle and downstream of surveyed Malikha River changes between 0 ~ 990.48ind./m² and average density is 176.19ind./m². Biomass changes between 0 ~ 4.9086g/m² and average value is 1.0794g/m².

4) Upper stream of Ayarwaddy River

Density of Zoobenthos in upper stream of surveyed Ayarwaddy River changes between 3.17 ~ 3758.73ind./m² and average density is 437.81ind./m². Biomass changes between 0.0024 ~ 24.0527g/m² and average value is 2.9585g/m².

(3) Comprehensive analysis on current status of Zoobenthos

Through this survey, it is observed Ayarwaddy Watershed has abundant species related to Zoobenthos as much as 139 species (genera or family), which are mainly composed of aquatic insects and Oligochaete species. Aquatic insects are dominant clusters, taking up 91.37% of total species. Species under Oligochaete are relatively few, only taking up 5.76%.

Observing the number of species in 4 regions mentioned above, they are ordered as: middle and upper stream of Maykha River>downstream of Maykha River>upper stream of Ayarwaddy River> middle and downstream of Malikha River with 85 species, 71 species, 59 species and 30 species respectively. According to average densities in 4 regions, they are ordered as: downstream of Maykha River>upper stream of Ayarwaddy River>middle and upper stream of Maykha River >middle and downstream of Malikha River being 578.9ind./m², 437.8ind./m², 339.4ind./m² and 176.2ind./m² respectively. The species and average densities in 4 regions are seen in figure3.3-7 and figure3.3-8.

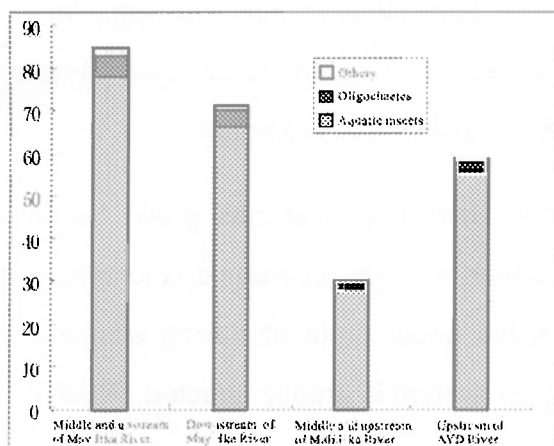


Figure 3.3-7 Comparison lists of species in 4 surveyed regions

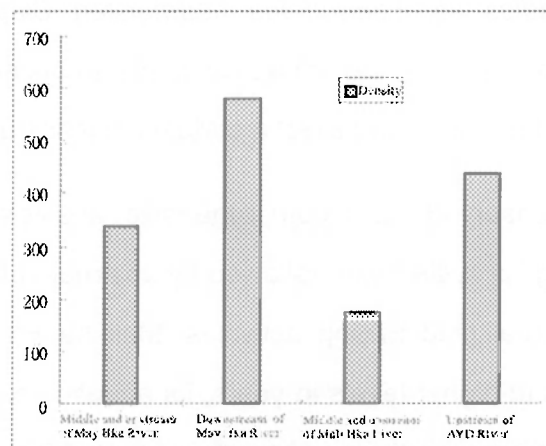


Figure 3.3-8 Comparison lists of densities in 4 surveyed regions

The number of species and biomass is at minimum in Malikha River, which is possibly related to amoy alluvial gold mining activities in middle and downstream of Malikha River,

and high content of sands in waters, sheltering places lived on by Zoobenthos are disturbed. Middle and upstream of Maykha River is located in mountainous areas at higher altitude, with scarce population, water flowing at rapid speed and diverse ecological environment types, which constitutes the significant reason why each sampling cross section has a large amount of species in this waters. However, biomass of Zoobenthos in middle and upstream of Maykha River is significantly lower than that in downstream of Maykha River and upstream of Ayeyawady River, indicating slow flows and increment of nutritious matters are beneficial to growth and proliferation of Zoobenthos.

Seen from the perspective of species occurring in Zoobenthos, a majority of species have strict requirements toward ecological environments; their ecological adaptability is weak and sensitive toward pollutions. Trichoptera, Ephemeroptera and Plecoptera which prefer living in cold flowing waters with no pollution and have weak ecological adaptability take up a higher proportion in surveyed cross sections. However, Oligochaete deemed as anti-pollution species has a low occurrence ratio and occupied proportion among total species, which indicates that the surveyed sections have sound water quality as whole, and ecological environment is good with few disturbance by human activities. Some anti-pollution species occur in partial cross sections in upstream of Ayarwaddy River, e.g. *Procladius* sp, *Limnodrilus hoffmeisteri* Claparède and *Cryptochironomus* sp., which possibly because the population is more centralized in this region, human activities take place frequently and exert a certain influence on water quality in this section.

It is observed from comprehensive analysis that: Maykha River has much healthier ecological system and followed by upstream of Ayarwaddy River, whereas due to influence of alluvial gold mining activities, Malikha River stays under state of having suspended sands at higher levels in years, its aquatic ecological system is greatly affected, which not only decreases the number of species of Zoobenthos but also causes sharp reduction of biomass in Zoobenthos.

3.3.2.4 Periphytic algae

Totally 26 genera and 125 species of benthic diatoms are collected in this survey. Specific

list is seen in appendix 8. Among them, there are 31 species under *Navicula*, 16 species under *Achnanthes*, 13 species under *Nitzshia*, 11 species under *Gomphonema*, and 10 species under *Cymbella*, species under other genera are less than 10.

(1) Species composition of periphytic algae

1) Middle and upstream of Maykha River

Totally 90 species and 19 genera under benthic diatoms are identified in 6 cross sections in waters of middle and upstream of Maykha River, among which, there are 23 species under *Navicula*, 15 species under *Achnanthes*, 9 species under *Nitzshia*, 7 species under *Gomphonema*, 8 species under *Cymbella* and 7 species under *Fragilaria*, species under other genera are less than 5; Common types are *Achnanthes minutissima*, *Achnanthes biasoletti* var. *subatomus*, *Achnanthes subhudsonis*, and *Achnanthes atomus*.

2) Downstream of Maykha River

Totally 80 species and 18 genera under benthic diatoms are identified in 7 cross sections in downstream of Maykha River, among which, there are 22 species under *Navicula*, 14 species under *Achnanthes*, 8 species under *Nitzshia*, 7 species under *Gomphonema*, 7 species under *Cymbella* and 5 species under *Fragilaria*, species under other genera are less than 5; Common species are *Achnanthes minutissima* var. *gracillima*, *Achnanthes biasoletti* var. *subatomus*, *Achnanthes subhudsonis*, *Navicula bryophila* and *Navicula schroeteri* var. *symmetrica*.

3) Middle and downstream of Malikha River

Totally 52 species and 17 genera under benthic diatoms are identified in 3 cross sections in middle and downstream of Malikha River, among which, there are 8 species under *Navicula*, 12 species under *Achnanthes*, 2 species under *Nitzshia*, 6 species under *Gomphonema*, 3 species under *Cymbella* and 2 species under *Fragilaria*, species under other genera are less than 3; Common types are *Achnanthes minutissima* var. *gracillima*, *Achnanthes biasoletti* var. *subatomus*, *Achnanthes subhudsonis*, *Navicula bryophila* and

Navicula schroeteri var. *symmetrica*.

4) Upstream of Ayeyawady River

Totally 67 species and 17 genera under benthic diatoms are identified in 5 cross sections in upstream of Ayeyawady River, among which, there are 17 species under *Navicula*, 12 species under *Achnanthes*, 7 species under *Nitzschia*, 7 species under *Gomphonema* and 6 species under *Fragilaria*, species under other genera are less than 5; Common types are *Achnanthes minutissima*, *Achnanthes biasoletti*, *Achnanthes biasoletti* var. *subatomus*, *Achnanthes subhudsonis*, *Achnanthes atomus*, *Melosira varians* and *Cymbella turgidula*.

(2) Density of periphytic algae

1) Middle and upstream of Maykha River

In such surveyed waters, benthic diatoms density changes between $0.18 \sim 6.4 \times 10^{10}$ cells/m², and average density is 2.77×10^{10} cells/m². Viewing from its composition abundance, except individual sections, *achnanthes* in other cross sections have obvious advantages; the proportions are all above 50%.

2) Downstream of Maykha River

In such surveyed waters, benthic diatoms density changes between $0.26 \sim 28.2 \times 10^{10}$ cells/m², and average density is 7.07×10^{10} cells/m². Viewing from its composition abundance, except an individual section, *achnanthes* have obvious advantages in other cross sections; the proportions are all above 30%.

3) Middle and downstream of Malikha River

In such surveyed waters, benthic diatoms density varies between $0.59 \sim 1.98 \times 10^{10}$ cells/m², and average density is 1.19×10^{10} cells/m². Viewing from its composition abundance, except an individual section, *achnanthes* have obvious advantages in other cross sections with the proportion being above 50%.

4) Upstream of Ayeyawady River

In such surveyed waters, benthic diatoms density varies between $1.99 - 14.61 \times 10^{10}$ cells/m², average density is 7.58×10^{10} cells/m². Viewing from its composition abundance, *achnanthes* have obvious advantages with the proportion of each section being above 40%.

(3) Comprehensive analysis of current status of periphytic algae species

According to the number of species in 4 regions, they are ordered as: middle and upstream of Maykha River > downstream of Maykha River > upstream of Ayeyawady River > Middle and downstream of Malikha River, with 90 species, 80 species, 67 species and 52 species respectively; through average densities of 4 regions, upstream of Ayeyawady River > downstream of Maykha River > middle and upstream of Maykha River > Middle and downstream of Malikha River being 7.58×10^{10} cells/m² , 7.07×10^{10} cells/m² , 2.77×10^{10} cells/m² and 1.19×10^{10} cells/m² respectively. Species and average densities in 4 research regions are listed in figure 3.3-9 and figure 3.3-10.

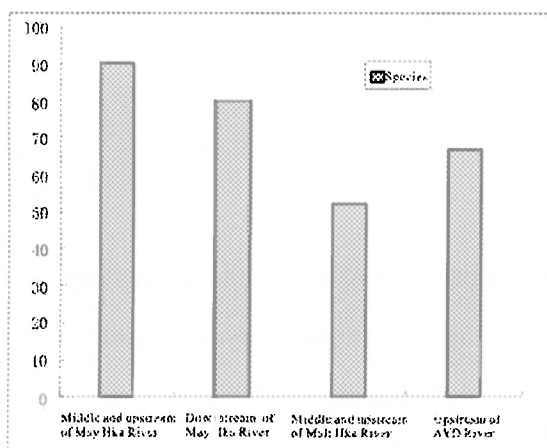


**Figure 3.3-9 Comparison lists of species
in 4 research regions**

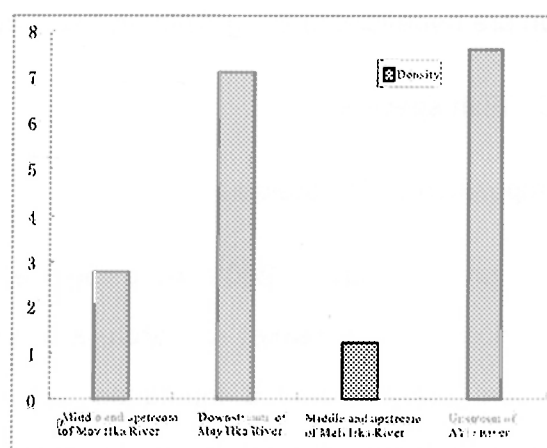


**Figure 3.3-10 Comparison lists of densities
in 4 research regions**

There are many periphytic algae species in middle, upstream and downstream of Maykha River, mainly because elevation changes greatly, habitats are more complicated and changeable, quantity of species are most abundant in the Maykha River region. However, in middle and upstream of Maykha River, the average density for periphytic algae species is low, indicating a rapid water flow which is not beneficial to the growth and accumulation

of periphytic algae species.

In middle and downstream of Malikha River, species numbers and average density are the lowest, which are possibly related with alluvial gold mining activities frequently undertaking, causing great reduction in water transparency and affecting habitats of periphytic algae.

In upstream of Ayeyawady River and downstream of Maykha River, average density of periphytic algae is comparatively higher. That is because population in this region is more concentrated, human activities take place frequently and aquatic nutrients are relatively rich. All these are good for the growth and accumulation of aquatic organisms.

Overall, water quality in Maykha River is sound, with multiple habitat types and healthy aquatic ecosystem; owing to amoy alluvial gold mining activities, sections in middle and downstream of Malikha River are under conditions of having a higher level of suspended sand sediments all year round, and the aquatic ecosystem has been effected greatly; for the upstream of Ayeyawady River, the concentrated population and a higher level of water nutrition are beneficial to the growth and accumulation of aquatic organisms.

3.3.2.5 Fish species

(1) Composition of fish species

From Januray to May in 2009, by using the methods of setting gill nets, casting nets, deep-fried catch and market research, a survey on fishery resources is conducted in 9 mainstream sections and 6 tributaries sections in Ayeyawady River above Myitkyina. Sections surveyed are shown in table 3.3-9.

During the survey, totally 1087 fish samples are collected, belonging to 96 species, 21 families and 7 orders. These fish samples are mainly composed of Cypriniformes and Siluriformes, accounted for 80% of total species. Among them, Osteoglossoformes, Beloniformes, Perciformes and Clupeiformes species only appear in the catches in upstreams of Ayeyawady River, showing the characteristics of the upstream of Ayeyawady River as a junction of Malikha River, Maykha River and Ayeyawady River. Meanghile, *Anguilla*

bengalensis and *Anguilla nebulosa* are only appear in a market survey made to Machanbaw sections. Combining the results of FishBase and *Yunnan Ichthyography, Inland fishes of Myanmar*, possibly 195 freshwater fish species are distributed in the upstream of Ayeyawady River above Myitkyina, belonging to 24 families and 10 formesorders. Fish list is seen in appendix 4.

Table 3.3- 9 List of survey cross sections of fish species

Regions		Sections	Remarks
Maykha River	Yenam	Panwandi	Downstream sections of Namtama River
	Kawnglanghpu	Kawnglanghpu Sections	Mainstream
	Pisa	Pisa Sections	Tributary of Mehk Rame down sections,
	Pisa	Pisa Sections	Tributary of Ngawchan Hka down sections
	Wutsok	Wutsok Sections	Mainstream
	Chibwe	Chibwe Sections	Mainstream(Chibwe dam site area)
	Chibwe	Chawngdam Sections	Mainstream
Middle and downstream of Malikha River	Chibwe	Shingaw Sections	Tributary of Tampang down sections
		Lawsarhtu Sections	Secondary tributary of Namtsang River
		Makuiza Sections	Middle sections of Namtsang River
	Laza	Machanbaw Sections	Ma Chen Baw Mainstream
		Laza Sections	Mainstream
Upstream of Ayeyawady River	Myitsone	Layan Sections	Mainstream
		Myitsone Sections	Hydrological Pier of Myitsone Mainstream
	Myitsone	Myitkyina Sections	Bridge of Myitkyina Mainstream

Because Osteoglossoformes, Beloniformes, Perciformes and Clupeiformes species are only appear in the catches in upstream of Ayeyawady River, whereas, Anguilliformes species are only appear in a market survey made to Machanbaw sections of Malikha River. Meanwhile, Cypriniformes and Siluriforme species take a large proportion among species in the surveys. Hence, according to the river location of collected fish sampling, the fish samples under Cypriniformes and Siluriformes will be allocated into the middle and downstream of Malikha River, Maykha River and upstream of Ayeyawady River for analysis. Statistical results are shown in Table 3.3-10 and Figure 3.3-11.

Table 3.3-10

Numbers of fish species in different rivers

Category		Maykha River	Middle and downstreams of Malikha River	Upstream of Ayeyawady River
Cypriniformes	Cobitidae	0	3	3
	Nemacheilinae	0	1	1
	Cobitinae	0	1	1
	Cobitidae	0	1	1
	Cyprinidae	18	19	29
	Danioninae	2	3	5
	Gobioninae	2	2	4
	Barbinae	5	6	8
	Labeoninae	4	5	9
	Schizothoracinae	5	3	2
	Cyprininae	0	0	1
Siluriformes	Siluridae	0	0	3
	Bagridae	0	1	4
	Sisoridae	5	1	3
	Heteropneustes fossilis	0	0	1
	Schilbidae	0	3	4
	Siluridae	0	0	1
	Siluridae	0	0	1

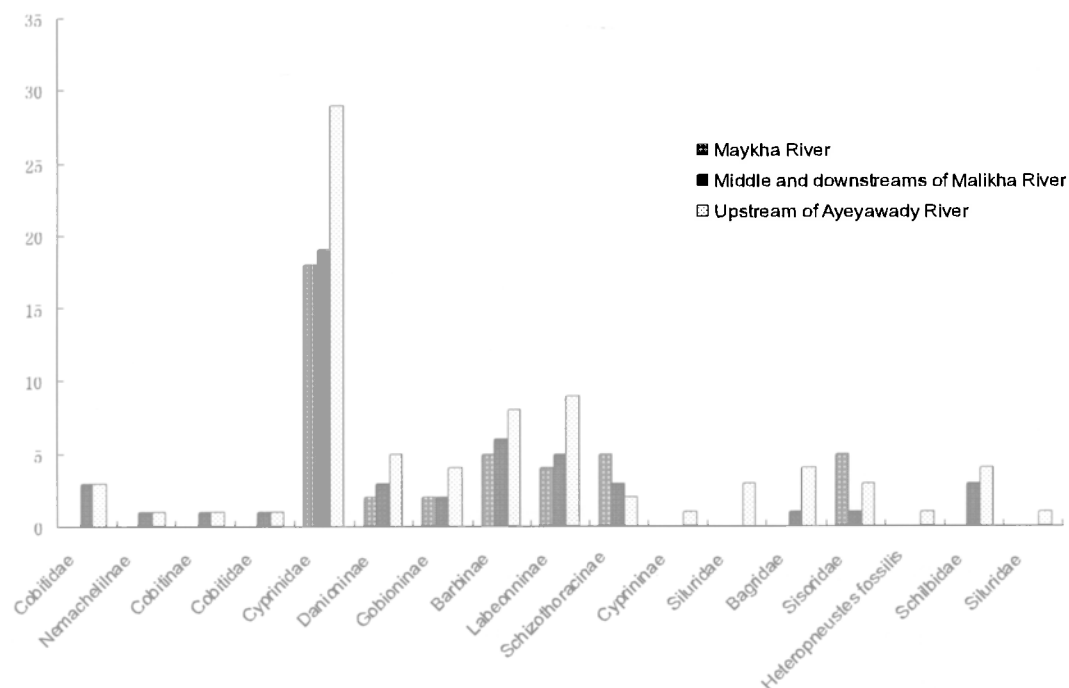


Figure 3.3-11 Fish species comparative table in different rivers

Statistical results show that the differences on fishes species between Maykha River and the middle and downstreams of Malikha River is significant, reflecting the two rivers have difference in their ecological environments. Fish species in Maykha River are dominated by species adapting to water environment flowing rapidly, such as, *Scaphiodonichthys*, *Sisoridae*, *Glyptothorax* and *Pseudecheneis*; in the middle and downstream of Malikha River, species adapting to water environment flowing slowly take dominant positions, e.g. *Labeo pierrei*(with maximal number), *Bangana delvdevi*, *Onychostoma gerlachi*, *Neolisschilus hexagonolepis*, and *Barilius barila*.

Comparatively speaking, fishes species under Cobitidae, Cyprinidae, Danioninae, Barbinae, Labeoninae, Schizothoracinae, Pangasiidae and Schilbidae in middle and downstream of Malikha River is close to those in Ayeyawady River. To some extent, this reflects the similarity on water ecological environment in upstream of Ayeyawady River and the middle and downstream of Malikha River. The fish species mainly include those adapting to the environment of water flowing slowly, e.g. *Heteropneustes fossilis*, *Silonia*, *Clarias batrachus*, *Eutropiichthys vacha*, *Mytus pulcher* under Pangasiidae, *Barilius barila*, *Rasbora*, *Barilius barnoides*, *Tor putitora*, *Labeo boga*, *Labeo gorius* under Cypriniformes.

(2) Life history of fish

1) Reproduction habits

Based on the collected records about relevant fish habits and analysis with related species, a vast majority of species in the surveyed regions are fishes laying sticky, sinking types of eggs. For these species, their reproductive migratory distances are normally short and reproduction naturally completes in habitats. This may be related to the rapid flow environment in the valleys within such waters that have no other auxiliary water bodies except mainstreams and tributaries on both banks. Therefore, their spawning migration is often anadromous by moving along the main stream for a short distance, laying eggs in different substrate shallows, or entering nearby mountain creeks, and anadromously laying eggs into these creeks. For example, Schizothoracinae, Sisoridae, and Siluridae are often laying eggs in water environment of tributaries; Labeoninae, Cobitidae, Channidae are

laying their eggs in slow or static waters, with disperse spawning grounds.

2) Feeding habits.

According to the major food composition for fishes, fish feeding habits in surveyed regions are mainly divided into four categories: periphytic algae feeding habit, benthic invertebrate feeding habit, omnivorous feeding habit and piscivore feeding habit.

① Fishes which mainly feed on periphytic algae. These kinds of fish generally have wide oral fissure, sharp horny in front edge of mandibular, and adapt to the way of feeding algae growing on stones by scraping, e.g., Labeoninae, Schizothoracinae and Cobitidae.

② Fish which mainly feed on benthic invertebrate, e.g. some species under Sisoridae, Schizothoracinae and Siluridae. Their mouths often have well-developed tentacles or hypertrophic lips used to absorb food. Regarding the intaken food, except only a small part of food are Chironomidae larvae and Oligochaetes growing in deep pools and tranquil flow sections, a majority of food are larvae or nymphs under Trichoptera, Plecoptera, and Ephemeroptera growing between gravels in rapid flows and stone cracks in rivers. The proportion of this type of fish species is comparatively large.

③ Omnivorous fish. They both feed on benthonic animals, aquatic insects, and residues and seeds of algae and plants. For example, small fishes like *Osteobrama belangeri*, *Amblypharyngodon atkinsonii*, *Rasbora*, Barbinae.

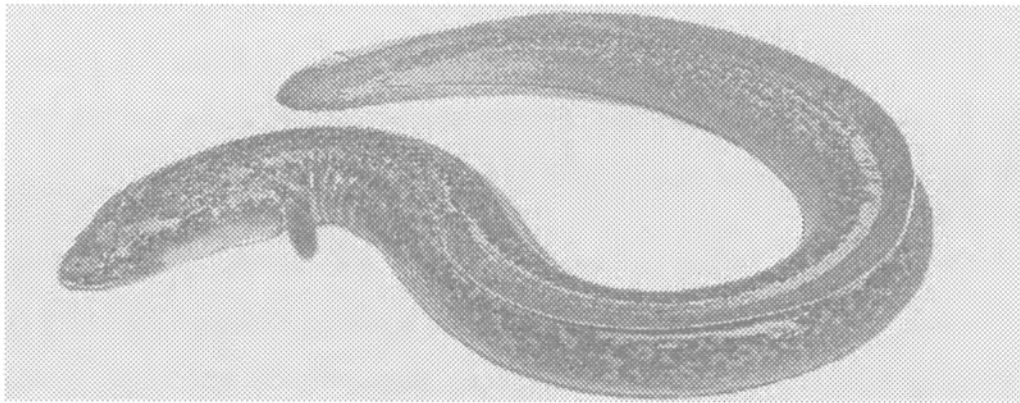
④ Piscivore fish. They are fierce and mainly prey on other small fishes. For example, *Bagarius yarrelli*, *Channa aurolineata*, *Wallago attu*, *Raiamas guttatus*.

Overall speaking, feeding habits of fishes have close connection with biological basis of baits in this region, showing that fishes species composition has a high relevancy with flowing environmental features in sections of hydropower development

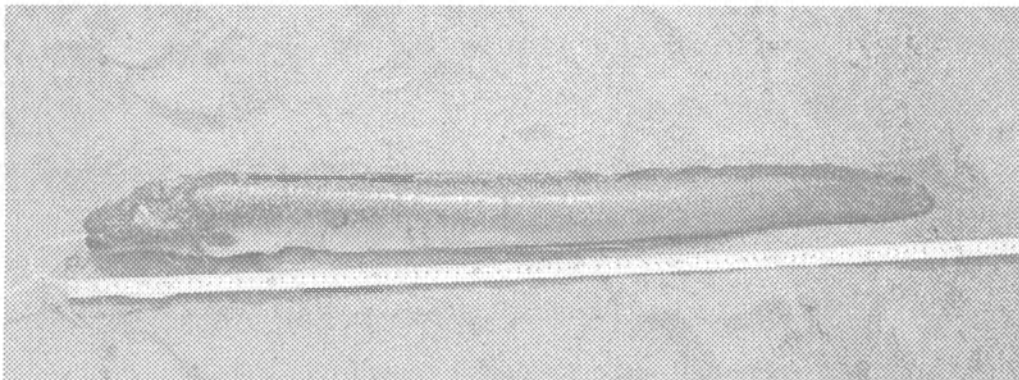
3) Migration habits

① Diadromous fishes. Combining the field survey and literature findings, the results show that no fish species laying eggs anadromously are distributed here. But based on the

market survey made to Machanbaw, *Anguilla bengalensis* and *Anguilla nebulosa* have typical catadromous and reproductive characteristics. The spawning sites are in the deep-sea waters of Indian Ocean, and the larval migrate into fresh water hunting for baits and fattening.



Anguilla bengalensis



Anguilla nebulosa

② Potamodromous fishes. This type of fish usually refers to those that complete entire life cycle in freshwater, but the feeding grounds and spawning grounds are relatively far from each other. Thus during different life stages, they should have regular migration. For fish species living in the rivers, its larval fish have a weak ability to defend streams, and are often carried and dispersed with water, flowing into downstream for hunting for baits and fattening, which constructs a significant adaptability for the proliferation and growth of species. However, fishes of different spawning types have a quite different migration distance. As for the fish living in open water area and laying pelagic eggs, for example, Four

Chinese Carps and *Coreiusheterodon*, *Coreius Guichenoti* and other species, the fertilized eggs often drift hundreds of kilometers away with the water. But for the species which lay sticky sinking eggs along coastal waters, since they stay at early developmental stages in slow or static water, the spreading distance is relatively short. During this survey, no pelagic eggs are collected. According to analysis from breeding habits of domestic closely related species, Cobitidae species in sections of hydropower development may have a breeding habit of laying pelagic eggs, for example, *Syncrossus berdmorei*, *Botia rostrata* etc. Their breeding habits still need further confirmation.

③ Fresh water sedentary fishes. These fish species are usually widely distributed in freshwater area. They are commonly small in size and lay sticky sinking eggs along coastal waters. Ecological environment range of completing their life cycle is relatively small, thus they can complete total life cycle in partial sections of still or slow waters. There are a large amount of fishes of these species in surveyed region, for example, *Channa punctata*, *Channa aurolineata*, *Clarias batrachus*, *Labeo boga*, *Labeo calbasu*, *Puntius chola*, *Raiamua guttatus*, *Anabas testudineus*; *Notopterus notopterus*, *Mastacembelus unicolor*, *Crossocheilus latius*, *Pangasius pangasius*, *Bagarius yerralli*, *Eutropiichthys vacha* and so on.

④ Amphidromous fishes. This type of fish has the characteristic of adapting a wide range of salinity, consequently distribute widely in coastal waters, estuaries and freshwater. But analysis from their breeding habits, there is no need for them to migrate between fresh and salt water to complete their life cycles in all aspects. Freshwater species are usually able to complete their entire life cycles in fresh water, and the cable feeding grounds and spawning site are basically overlapping. For example, the fish species collected in this survey, like *Xenentodon cancila*, *Mystus carvasius*, *Silonia silondia* and other species are actually freshwater sedentary species.

4) Habitat selectivity

Hydropower development region is at the upstream of Ayeyawady River, where no lakes are developed, different rivers are all manifested as flowing characteristics. Referring to the

Transverse Mountain Fish for classification of different habitats types, the river sections of this hydropower development mainly include three types of habitats, gorge rivers, mountain streams and hill rivers.

① Gorge rivers. The valley is narrow in V shape and has steep slope with anxious flows and more beachheads. River bed is mainly made of rocks and gravels, and beaches only occur in partial whirl of water sections. The main sources of waters are from upstream sections and mountain streams in valleys. With a large amount of water, water flow effects violently on regressive erosion and transportation. It is very difficult for the river- borne materials to deposit, especially in the flood period, water is turbid and the water level soars. Due to the depth of rapid flowing water, short duration of sunshine radiation and low water temperature, though rich aquatic species are available, its biomass is still poor; the aquatic vascular plants can hardly grow in the rivers. In sections of this hydropower development, sections above Chibwe of Maykha River fall into this category, where mainly distributed fish species include rapid adapted fishes under Schizothoracinae and Sisoridae, but fish species that adapt to slow flow environment are few.

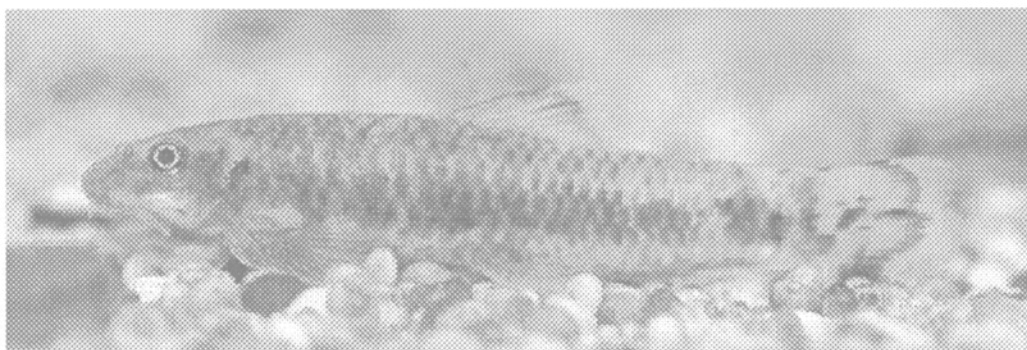
② Mountain streams. They are distributed in the valley among the mountains at dense proportion, and water level changes greatly. After heavy rains, it rises sharply then followed by a rapid drawdown. Substrate is made of bedrock or gravel. With shallow water and less suspensions contained, the streams are cleared-bottomed. As the water volume is small and water develops small transportation function, the river bed is relatively stable. There are many rotted leaves of terrestrial plants among the abreuvoir deposits. This provides a breeding ground for fixed aquatic plants, Zoobenthos and the periphytic algae. The water temperature is low and dissolved oxygen often reaches saturation. A number of tributaries of Malikha River and Maykha River fall into this type of habitat conditions. In these tributaries, fish species are mainly small fishes living in flows, e.g. some small species under Balitoridae and Barbinae.

③ Hill rivers. These waters mainly situate in the transition area between gorge rivers and plain rivers. They both have the plain river and gorge rivers' characteristics, riching in aquatic

organisms. Fish species composition has also the upstream and downstream water body characteristics. In the hydropower development regions, this feature is shown in sections lower than Man Nansai of Malikha River, downstream of Maykha River, and Ayeyawady River above Myitkyina. Rapid adapted fishes normally exist in gorge river and the fish species adapt to low flowing rate in plain river are all distributed in the above river sections. Except Barbinae and Labeoninae species, there are also distributing fish normally seen in middle and downstream sections, for example, gobioninae and Cyprininae in Cypriniformes, Bagridae, Siluridae, Clariidae, Heteropneustes, Schilbeidae and Pangasiidae of Siluriformes. However, cold-water Schizothoracinae species are absent here.

(3) Endemic fish species

According to FishBase records, in the Ayeyawady River watershed distribute 4 kinds of local fish species. They are *Garra poecilura* (One kind of *Garra* sp.), *Hemibagrus peguensis*, *Schistura acuticephalus*, and *Schistura paucifasciata*. However, in this survey none of them are discovered. This may be caused by the low sampling intensity during this survey. And it is also possible that these species' main distribution areas are not yet within the river reaches of hydropower development.



***Garra poecilura* (One kind of *Garra* sp.)**

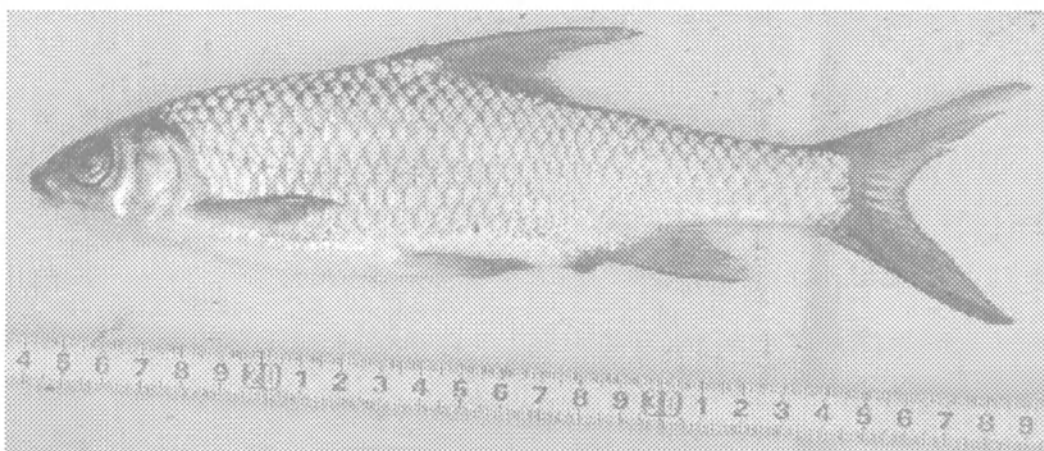
(4) Major commercial fishes

During the survey, fish with larger sample numbers include *Labeo pierreii*, *Tor putitora*, *Bangana delvadei*, *Neolissochilus hexagonolepis*, *Schizothorax meridionalis*, *Garra qiaojiensis*, and *Neolissochilus stracheyi*. Besides, *Mystus pulcher*, *Parambassis ranga*,

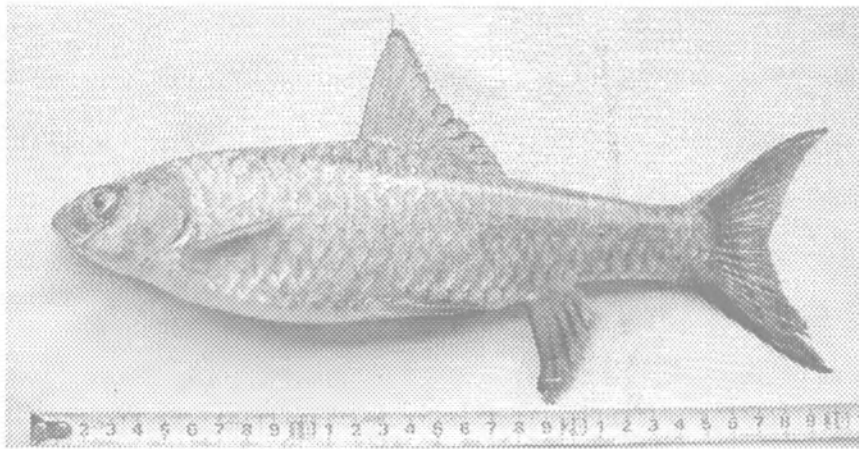
Amblypharyngodon atkinsonii, *Tor tambroides* and *Crossocheilus latius* are also remain in number. Table 3.3-11 shows the number and percentage of fish samples, body length scope and weight scope. As can be seen from the table, maximum weight of *Neolissochilus stracheyi* and *Neolissochilus hexagonolepis* reaches up to 4000g, weight of *Schizothorax meridionalis* and *Bangana delvdevi* exceeds 1000g, thus they become potentially important fisheries targets. Though *Tor putitora*, *Labeo pierrei*, and *Garra qiaojiensis* have relatively small bodies, the fairly large numbers of them also have certain economic values. Other species with extremely small bodies have relatively low fishing value.

Table 3.3-11 Body length scope and weight scope of major economic fishes

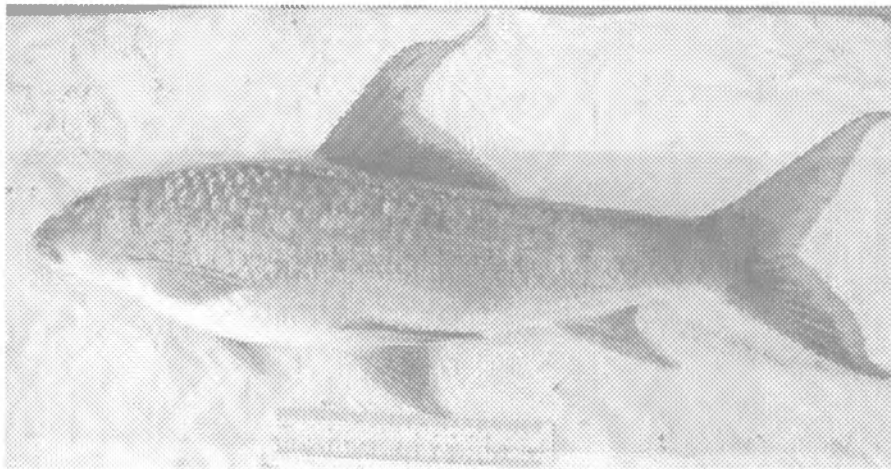
	Sample number	Mantissa percentage	Body length scope(mm)	Weight scope(g)
<i>Labeo pierrei</i>	137	12.60%	72-218	5.5-158.4
<i>Tor putitora</i>	72	6.62%	90-265	11-347.8
<i>Bangana delvdevi</i>	66	6.07%	175-300	35-1284.4
<i>Neolissochilus hexagonolepis</i>	37	3.40%	95-560	7.8-4000
<i>Schizothorax meridionalis</i>	31	2.85%	82-425	8.3-1312.7
<i>Garra qiaojiensis</i>	31	2.85%	123-209	39.7-208
<i>Neolissochilus stracheyi</i>	28	2.58%	103-550	18.1-4000



Labeo pierrei



Tor putitora



Bangana delvdevi

(5) Distrubution of Major commercial fishes

Based on the analysis of fish sampling sites, 7 kinds of fishes, *Labeo pierrei*, *Tor putitora*, *Bangana delvdevi*, *Neolissochilus hexagonolepis*, *Schizothorax meridionalis*, *Garra qiaojiensis*, and *Neolissochilus stracheyi*, are distributed as shown in figure 3.3-12. Seen from the environmental characteristics of distribution waters, *Labeo pierrei* and *Neolissochilus stracheyi* are mainly distributed in primary and secondary tributaries of Machanbaw sections of Malikha River; *Tor putitora* is distributed in Chibwe of Maykha River, Laza of Malikha River, and Myitsone of Ayeyawady River; *Garra qiaojiensis* is only collected in Chibwe, Maykha River. These species are more likely to select the hill-rivers with relatively lower flow rate. However, *Neolissochilus hexagonolepis* and *Schizothorax*

meridionalis distributing in the upper and middle sections of Maykha River show the adaptability of Gorge river. Distribution of *Bangana delvdevi* is comparatively wide in Maykha River, Malikha River, and Ayeyawady River. For different habitats, it has a higher adaptability.

(6) Utilization status of fish resources

According to the survey, except the Myitsone River, other rivers' social economy is undeveloped. The utilization of fish resources is of a very low degree, with a single fishing method and simple working tools. There are no professional fishermen. Main fishing gears include single gill net, single-set gill nets and loglines (fishing bait) etc.

In the surveyed river area, local residents live mainly on cultivation and hunting. Fishing and aquaculture are both underdeveloped, and the fishery models are mainly based on subsistence fisheries. At the same time, there are some unreasonable fishing, for instance, toxic fishing, exploded fishing, using small mesh gear and so on.

3.3.2.6 *Orcaella brevirostris*

Orcaella brevirostris is one of only four freshwater finless porpoises in the world. They like grouping life, and prefer fish, cephalopods and other crustaceans as their food. *Orcaella brevirostris* live mainly in a shallow coastal zone, or in the muddy



freshwater of river estuary in Southeast Asia and Australia. Around the Asian continent, their distribution ranges from coasts of Bengal Bay to Malacca Strait and the Gulf of Thailand. Distribution is shown in figure 3.3-13. Freshwater groups are primarily distributed in the Ayeyawady River and the Mekong River. The river near Mandalay in Myanmar is the *Orcaella brevirostris*'s habitats. Under influence of shrinkage of their habitat areas (in the past few decades, habitat area has been reduced by nearly 60%), the group population has decreased significantly in recent years. Optimistically estimated, its total number is less

than a hundred, and is considered one of the most endangered finless species in the world. In 2004, *Orcaella brevirostris* has been included in the IUCN Red List as an endangered species. In order to protect this species from extinction, Government of Myanmar establishes a protected area extending approximately 72 km long below 330 km in downstream of Myitkyina. The location of *Orcaella brevirostris* protected area is shown in figure 3.3.-14.

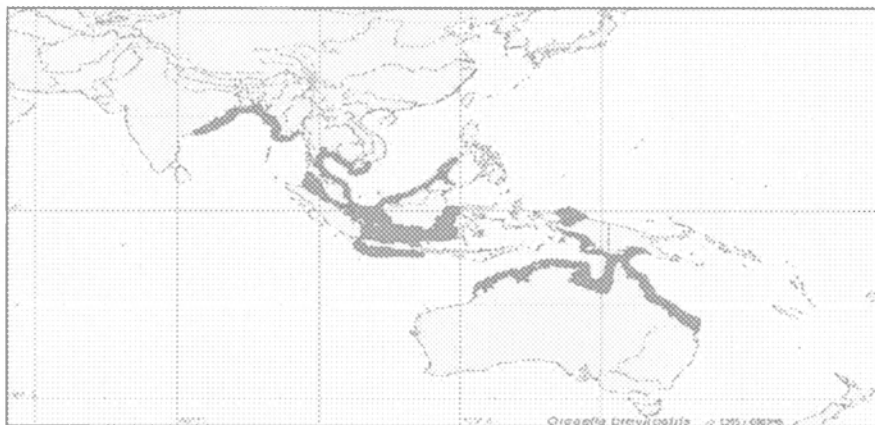


Figure 3.3-13 Distribution map of *Orcaella brevirostris*

3.3.3 Eco-Environment Quality Status

3.3.3.1 Vegetation biomass and growth volume in evaluation region

Biomass and growth volume are major quota to measure good or bad on eco-system function. Calculation of biomass and growth volume referred to the methods recommended in *Eco-Environmental Quality Analysis and Comprehensive Evaluation in Hainan Island*.

① Calculation of tree biomass equation is:

$$Bmf=0.00003396D^2H$$

In the equation: Bmf is biomass of forest communities (t for dry weight), D is breast-height diameter (cm), H is tree height(m).

② Calculation equation of woody layer productivity(growth volume) is:

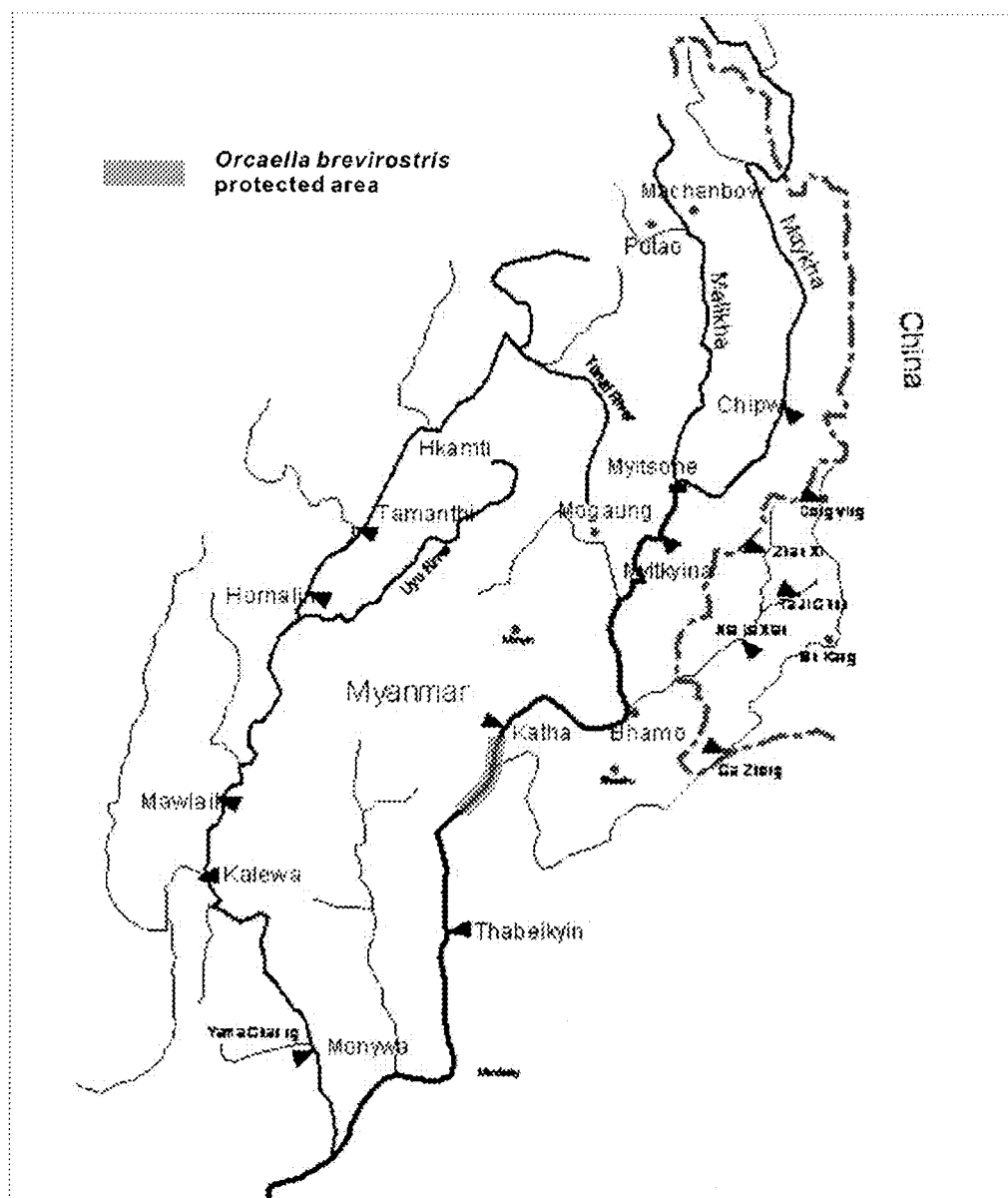


Figure 3.3-14 Location Map of Orcaella brevirostris protected area in Myanmar

$$Bg = 0.000010246 (D^2H)^{0.625}$$

In the equation: Bg is productivity (growth volume) (t), D is breast-height diameter(cm), H is tree height(m).

- ③ Calculation of biomass in shrub and herb layer adopts quadrat harvest method.

According to above estimating method, different vegetation types biomass and growth volume in evaluation region have been measured out. The results are shown in Table

3.3-14.

Table 3.3-14 List of biological productivity of different vegetation in evaluation region

Type Number	Types	Biomass(t/ha)		Growth volume(t/ha.a)	
		Tree layer	Shrub layer	Tree layer	Tatal growth volume
I-1	Form. Dipterocarpus sp., Shorea sp.	416.39	1.85	4.91	6.76
II-2	Form. Tetrameles nudiflora	203.9	1.25	2.72	3.97
II-3	Form. Duabanga grandiflora, Chukrasia sp., Polyalthia sp.	574.52	1.3	3.36	4.66
II-4	Form. Ficus sp., Spondias sp., Caryota gigas	337.83	1.35	3.36	4.71
III-5	Form. Castanopsis indica	215.73	1.05	1.47	2.52
III-6	Form. Castanopsis sp.	237.61	1.35	3.07	4.42
III-7	Form. Castanopsis diversifolia, C. acuminatissima	162.15	0.95	1.82	2.77
III-8	Form. Castanopsis calathiformis	135.56	0.85	2.58	3.43
III-9	Form. Castanopsis tribuloides	164.85	1.05	3.9	4.95
III-10	Form. Schima wallichii	450.28	1.5	6.41	7.91
III-11	Form. Engelhardtia spicata, Alnus nepaulensis	186.76	1.25	2.6	3.85
III-12	Form. Symplocos sp.	263.77	1.15	5.83	6.98
IV-13	Form. Bombax ceiba, Tetrameles nudiflora, Dendrocalamus sp.	439.93	1.05	7.79	8.84
V-14	Form. Shorea sp., Tetrameles nudiflora, Musa sp.	220.84	0.85	3.95	4.80
VI-15	Comm. Alangium sp., Bauhinia sp.-Mikania micrantha, Eupatorium odoratum	5.87	1.65	0.46	2.11
VII-16	Comm. Homonoia riparia-Rosa sp.-Arundodonax	3.99	1.35	0.42	1.77
VIII-17	Plantation of Hevea brasiliensis	187.78	0.35	1.84	2.19
VIII-18	Plantation of Citrus spp.	1.34	0.25	0.11	0.36
IX-19	Farm Oryza indicum, O. japonica		0.85		0.85
IX-20	Shifting Cultivation. Brassica sp., Zea mays, Panicum sp., Sorghum sp.		0.35		0.35

As can be seen from Table 3.3-14, different communities' structure and function are diverse obviously. Among them, biomass of tree layer of forest communities is between 135.56~574.52t/ha, which is quite different from the biomass of other communities. In a

community, the higher and bigger trees are, the greater its biomass has. In the primary forest and secondary forest mentioned above, with *Duabanga grandiflora*, *Chukrasia sp.* and *Polyalthia sp.* based communities have a high biomass; Followed by Form. *Schima wallichii*, Sparse tree and Bamboo and Form. *Diptero carpus sp.* Among them, Form. Sparse tree and Bamboo biomass is relatively higher than that of Form. *Castanopsis sp.* In this region, shrub and herb layers biomass varies comparatively small, and shrub and herb layers biomass in artificial community is smaller. Generally speaking, shrub and herb layers have relatively small biomass and growth volume.

Thus, vegetation in evaluation region is at the early stage of evolution and succession after vegetations are disturbed artificially. Vegetation coverage is better, but the stand quality is still poor, with a large part staying under early stage of secondary forest, leading to various tree layers has low biomass and total growth volume.

3.3.3.2 Biological diversity index in evaluation region

Biological diversity is an essential quota to reflect community's structural complexity and stability. The level of biological diversity is related directly to the communities' stage of succession, the degree of human disturbance and other factors. Generally, the community, which has a higher level of biological diversity, will have a higher stability. Therefore, the level of biological diversity is an important quota to reflect the degree of pros and cons on eco-environmental quality.

Biological diversity index(Shannon-Wirner diversity index):

$$SW = 3.3219 \left(\lg N - \frac{1}{N} \sum_{i=1}^s n_i \lg n_i \right)$$

In the equation: SW is Shannon-Wiener diversity index, N is total number of individuals in sample area, n_i is No. i species individual number, s is species volume.

According to above method, the Shannon-Wiener diversity index of natural vegetation types in evaluation region has been estimated. See Table 3.3-15.

Table 3.3-15 List of species diversity index of natural vegetation types in the evaluation region

Type Number	Type	Families species genera			species diversity index		
		Tree layer	Shrub layer	Herb layer	Tree layer	Shrub layer	Herb layer
I-1	Form. Dipterocarpus sp., Shorea sp.	220	86	48	6.66	4.11	2.36
II-2	Form. Tetrameles nudiflora	56	42	10	5	3.23	2.34
II-3	Form. Duabanga grandiflora, Chukrasia sp., Polyalthia sp.	84	56	15	5.5	3.88	2.13
II-4	Form. Ficus sp., Spondias sp., Caryota gigas	64	42	28	5.49	3.67	2.36
III-5	Form. Castanopsis indica	68	62	23	5.63	3.44	2.67
III-6	Form. Castanopsis sp.	103	55	43	6.01	3.56	3.01
III-7	Form. Castanopsis diversifolia, Castanopsis acuminatissima	40	38	31	4.81	3.12	2.78
III-8	Form. Castanopsis calathiformis	58	27	18	4.69	3.51	2.02
III-9	Form. Castanopsis tribuloides	75	52	28	4.88	2.98	2.13
III-10	Form. Schima wallichii	98	41	23	5.68	3.08	2.23
III-11	Form. Engelhardtia spicata, Alnus nepaulensis	69	32	18	5.43	3.32	2.09
III-12	Form. Symplocos sp.	76	36	21	4.49	3.33	2.58
IV-13	Form. Bombax ceiba, Tetrameles nudiflora, Dendrocalamus sp.	71	48	28	2.67	3.12	1.98
V-14	Form Shorea sp., Tetrameles nudiflora, Musa sp.	50	37	23	2.34	3.01	2.12
VI-15	Comm. Alangium sp., Bauhinia sp.-Mikania micrantha, Eupatorium oderatum	7	18	12	1.05	2.12	2.23
VII-16	Comm. Homonoia riparia-Rosa sp.-Arundo donax	8	21	17	2.67	2.08	1.84

As can be seen from Table 3.3-15, each type of natural vegetation has a significant difference on Shannon-Weiner Diversity index, varying between 1.05~6.66, among which the index of tree layers in primary forest and secondary forest is generally above 4.5. However, most of index is still lower than that of typical rain forest (generally at 6.0 or so) in this region. Whereas, taken as the main vegetations in this region, sparse tree and bamboo forest, and sparse tree and musa forest have lower diversity indexes, indicating that the

vegetations in evaluated area have strong secondary features.

3.4 Social environment

3.4.1 Social economy

Kachin State which is the Kachin Autonomous Prefecture lying in the northeast of the Union of Myanmar is bounded on the east by Nujiang Lisu Autonomous Prefecture and Dehong Dai and Jingpo Autonomous Prefecture of Yunnan Province, China and on the north by Qamdo Prefecture of Tibet Autonomous Region. The area of Kachin State is 89,000 km², about 13% of the area of Myanmar. Kachin State has jurisdiction over three cities of Myitkyina, Bhamo and Putao as well as 18 villages. It has a population of about 1.42 million, with a population density of 15.9 persons per square kilometer, and is the least densely populated of Myanmar. In plains areas such as Bhamo and Mogong Township, the population density can be 40 ~ 45 persons per square kilometer. Myitkyina, capital of Kachin State, has a population of about 200 thousand. In terms of sex ratio, Kachin people have 60% females and 40% males.

According to statistics, GDP per capita of the country was \$239 in 2007. Agriculture which employs 64% of the labor force and accounts for 50.5% of GDP is the basis of Myanmar's economy. Industry accounted for a lower percentage of GDP for a long time. In recent years, development has been accelerated, with industry increasing and accounting for 16.2% of GDP.

The pillar industry of Kachin's economy is agriculture. The main crops include rice, sorghum, maize, sugar cane, rape, etc. Rice is an important crop in this area, which makes up 75% of the total planted area and is mainly planted on the plain and mountain. In addition to agriculture, the main source of income depends on the jade and teak produced in Kachin State. Jade is found in Hanba, Longqin and other places while teak is distributed in Bhamo and Myitkyina.

Kachin's industry is yet to be developed. Industrial structure is dominated by farm crops