

Traditional Fishing Practices Among the Galo Tribes of Arunachal Pradesh, North East India

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ABSTRACT

Arunachal Pradesh is endowed with a rich diversity of ichthyofauna. The Galo tribes, predominantly inhabiting the central parts of the state, traditionally practice a wide array of fishing techniques using various types of fishing gear. These traditional practices are deeply intertwined with the tribe's rituals, beliefs, and ecological knowledge. The study documents the traditional fishing gears and techniques of the Galo fisherfolk in Arunachal Pradesh. To accomplish the work, a systematic survey was conducted from 2022 to 2024 through direct observations, personal interviews, and interactions with local fishermen living in the vicinity of the four rivers, viz., Jilu (Upper Subansiri), Ego (Lepa Rada), Hijum (West Siang), and Sigin Koro (Lower Siang). The study revealed that the fisherfolk of these areas have a rich and diverse range of indigenous fishing gears, reflecting a profound understanding of human-nature relationships. These implements, skillfully crafted from locally available materials using traditional knowledge and techniques, are integral to the region's customary fishery practices. Furthermore, these indigenous fishing methods support the sustainable management of fish populations and play a vital role in preserving cultural heritage and promoting biodiversity conservation amid a rapidly changing ecological landscape.

Key words: Traditional knowledge; Fishing techniques; Indigenous societies

INTRODUCTION

Fish and fisheries usually contribute to economic, social, and nutritional well-being and are vital to many societies. They provide essential micronutrients and high-quality animal protein (Thilsted et al. 1997, Roos et al. 2007, Anonymous 2012, Beveridge et al. 2013). Approximately 86% of the global fish production is for human consumption (Anonymous 2012, 2014). Nearly 60 million people in low-income countries rely on inland fisheries for their livelihoods, and women comprise more than half of the workforce in the supply chain (Anonymous 2014). Fisheries account for nearly 17% of the global animal protein intake, thereby enhancing food and nutritional security (FAO 2018), and generating jobs and income (Anonymous 2012, Hanazaki et al. 2012, Beveridge et al. 2013). Fish is a rich source of high-quality protein, vitamins, and minerals, offering essential nutrients such as calcium, comparable to skimmed milk, and proteins that support regulatory functions in the body (Holmlund and Hammer 1999, Mozaffarian and Rimm 2006, Sujatha et al. 2013). It plays a vital role in preventing

protein-calorie malnutrition and is superior to many other protein sources due to its balanced macronutrient and micronutrient profile (Lilly et al. 2017, Mohanty et al. 2019). Inland fisheries largely contribute to ecosystem functions and serve as indicators of global environmental change (Lynch et al. 2016). However, overexploitation and freshwater degradation threaten fish abundance and diversity, necessitating urgent conservation efforts (Sleen and Albert 2021).

Customary fishing techniques have evolved to catch targeted fish species, desired catch sizes, and suit local environments, making them highly effective in specific regions (Eyo and Akapati 1995). Their implementation depends on water physico-chemical parameters, fish abundance, and the availability of raw materials for gear fabrication (Hussain et al. 2016). The success of indigenous fishing techniques relies on location, timing, materials, and fish availability. They are simple, require minimal technical skills, and are primarily used for household consumption, resulting in a lower environmental impact compared to industrial fishing (Raju et al. 2016, Kechu and Pankaj 2023).

Knowledge of fishing gear, crafts, and methods is crucial for the sustainable exploitation and management of fisheries resources (Rao et al. 2016). In India, traditional fishing methods are widely practised and tailored to local fish behaviour and habitats (Raju et al. 2016). Notably, ethnic groups in Arunachal Pradesh possess diverse indigenous fishing techniques, but documentation remains sparse. Some studies have partially explored such practices, including the fish diversity of the Siyom River (Bagra and Das 2010), fishing in the Siang belt (Hussain et al. 2016), and traditional fishing methods in the West Siang district (Karga et al. 2020). Hence, a comprehensive knowledge and understanding of the traditional fishing techniques offer a valuable perspective on sustainable resource use, emphasizing harmony with nature, community involvement, and adaptive management (Gonzalez 2024). Therefore, this study attempts to explore the rich traditional fishing knowledge among the Galo tribes of Arunachal Pradesh and assess its significance in sustainable fishery management.

METHODOLOGY

Study area

The study area is located between 27° 59' N to 28° 16' N latitudes and 94° 40' E to 94° 80' E longitudes. It covers the districts inhabited by the Galo tribe, viz. West Siang, Lepa Rada, and Lower Siang. Additionally, the Maro and Baririjo circles in the Upper Subansiri district, inhabited by the Galo tribe, have also been included in this study. The study area is bounded by the Shi Yomi district in the north, Siang and East Siang districts to the east and southeast, Kurung Kumey district in the west, Lower Subansiri district in the southwest, and Assam in the south (Fig. 1). The northern part of the study area is mountainous and the southern part falls under the Sub-Himalayan belt and the Siwalik ranges. The average elevation ranged between 200 and 1700 m amsl. The area is drained by numerous rivers and rivulets, viz. Siyom, Sipu, Ego, Hijum, Sigin, Tai, Sii, Sibe, Siben, Sijik, Silu, Sibum, Baa, Kidi, Hi, Jale, etc., which are home to numerous fish species, including many endemic species. The area experiences a tropical monsoon climate characterized by minor variations due to its topographical features. It receives rainfall during the

summer season from June to September with an annual rainfall range of 150 - 5000 mm. The highest monthly average maximum and minimum temperatures are recorded from June to September. The winter season is generally cold and dry.

Data collection

A comprehensive field survey was conducted from 2022 to 2024 in the study area. During the field visits, in-depth observations and interviews were conducted to gather information and document the various fishing gear, techniques, and equipment employed by the people (Schonhut and Kieveltiz 1994, Gurumayum and Choudhury 2009). Through focused group discussions and interviews, the opinions and perceptions of the local population were collected regarding the status of fishing methods (continued or discontinued), legal and illegal fishing methods and equipment, use of plants and herbs, reliance on fishing for living, and conservation-related issues. The respondents included village heads, traditional knowledge keepers, fishermen, and members of local communities representing diverse age groups. Furthermore, secondary data was obtained from scientific literature, published papers, historical records, books, and reports from governmental organizations to understand the historical and cultural context of traditional fishing practices.

Fishing techniques

In this study, the fishing techniques are defined as any equipment, implement, tool, or method to catch, collect, or harvest fish. The documented traditional fishing techniques vary in size, shape, and mode of operation.

RESULTS

The Galo tribes of Arunachal Pradesh employ various traditional fishing techniques to catch fish primarily for subsistence (Table 1). The highest usage of fishing techniques was found in the post-monsoon (7 techniques, 35%), followed by winter (6 techniques, 30%), monsoon (4 techniques, 20%), and pre-monsoon (2 techniques, 10%). Only one technique is used throughout the year (Fig. 2). The stable conditions of rivers and increased fish availability after monsoon breeding can be attributed to the high

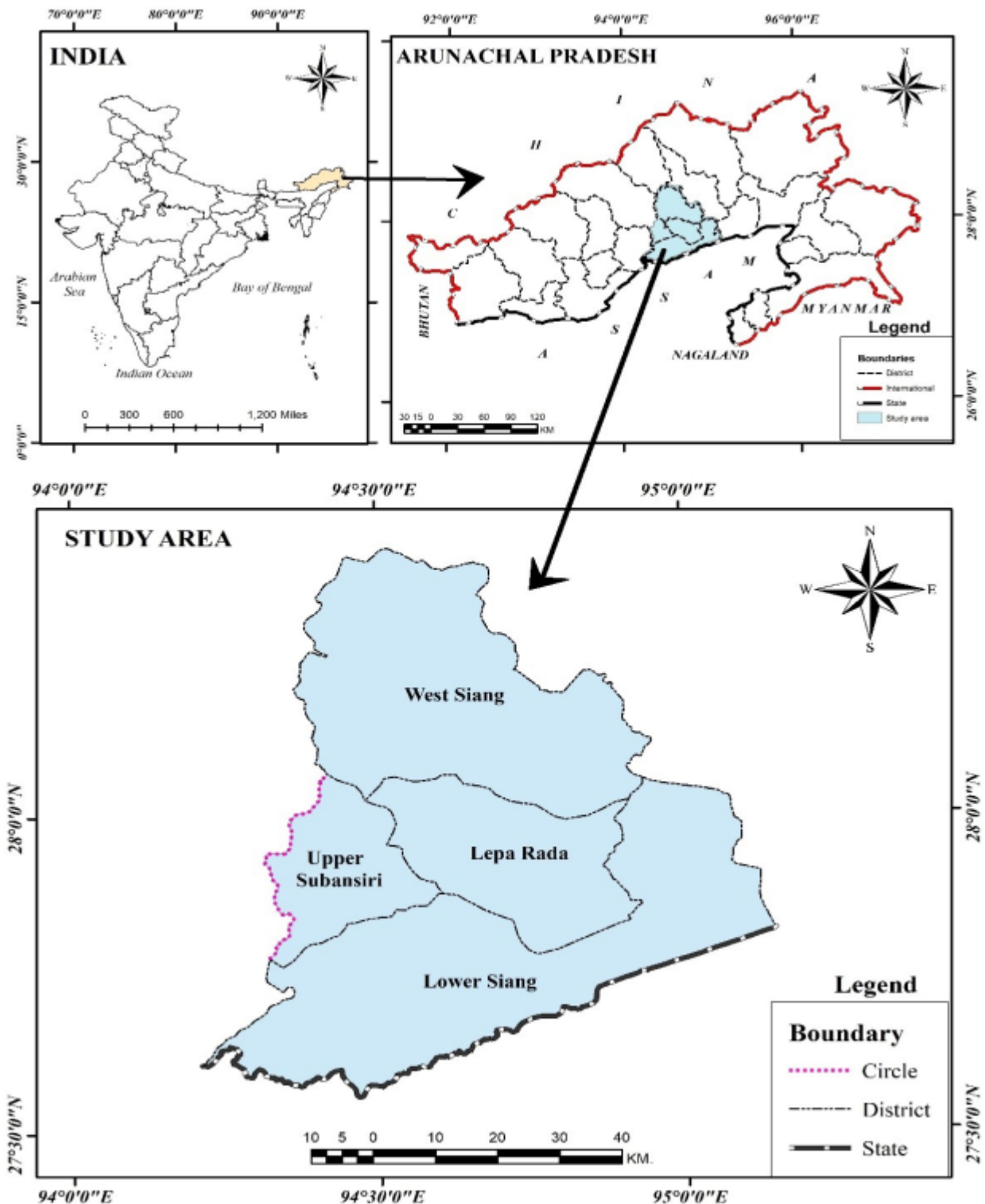


Figure 1. Location map of the study area

usage of fishing techniques during the post-monsoon and winter seasons.

Fishing nets

Cast net: Cast nets, locally known as *Vhap* or *Vsap*

Vrnam (Fig. 3F), are a widely practised fishing technique among the Galo men throughout the year. The net, weighted with a component called *Habro* or *Habkor*, is adapted based on the river’s depth; lighter nets are used in shallow waters and heavier

Table 1. Traditional fishing techniques practiced by the Galo tribes of Arunachal Pradesh

Fishing techniques	Local name	Materials used	Season	Status
Fishing nets				
Cast net	<i>Vhap</i> or <i>Vsap</i> <i>Vnam</i>	Fibers of a plant (Traditional), nylon/ synthetic fibers (Modern)	TTY	SP
Wounding gears				
Hooks and lines	<i>Vkvr</i> or <i>Gvkvv</i> (<i>Kvrci</i>) <i>Vkvr</i> or <i>Gvkvv</i> (<i>Krtv</i>) <i>Vkvr</i> <i>Rwwnam</i> or <i>Ngobv Rwwnam</i> <i>Ngoi Abnam</i> or <i>Moohap Abnam</i> <i>Heak Hwnam</i> or <i>Jatka</i>	Iron hook, nylon twine, bamboo pole Iron hook, nylon twine, bamboo pole Iron hook, nylon twine, bait Wooden stick / sharp iron tip Iron hook, nylon twine, bamboo pole, bait	PM M M PM PM	SP SP SP B SP
Noose fishing	<i>Ngoi Ognam</i>	Nylon twine, bamboo pole, stone	PM	SP
Herbal poisoning	<i>Hentvm</i> or <i>Hwwb Rwwnam</i>	Ritualized fishing involving the use of herbal poisons (fruits of <i>Zanthoxylum rhetza</i>)	PM	OP
Ritualized fishing	<i>Lwru Hwnam</i>	Plugging the stone gaps with herbal poisons	PRM	SP
Local fish traps				
Conical-shaped	<i>Tasum Kwnam</i> <i>Rwwgo Goonam</i> <i>Takom Gaanam</i>	Bamboo splits, cane strings Bamboo splits, cane strings Bamboo splits, cane strings	W W PM	SP SP SP
Funnel-shaped				
Line without a hook	<i>Hoom, Pokam</i> or <i>Rwwde Dwnam</i>	Locally crafted fishing line, conical funnel, short bamboo pole, and bait	W	SP
Other techniques				
River course diversion	<i>Hibok Pwnam</i>	Mud, rocks, boulders, plants, wild banana leaves, and herbal poisons	M	SP
Lured fishing	<i>Hipw Tunnam</i> <i>Hipv Panam</i>	Damming a section of a small stream, fed by natural baits and trapped with a conical basket A barrier made of wood, cane, bamboo, and wild banana leaves across a stream	W W	MA MA
Stone heap fishing	<i>Lwvpum</i>	Stones, bamboo mat, conical basket	W	SP
Bare-hand fishing	<i>Lwvruu Inam</i>	It involves catching fish bare-handed without the aid of any supplementary fishing tools	PRM	SP
Floodwater fishing	<i>Ngouu</i> or <i>Ngoru Lanam</i>	Fishing in water filled during a flood using baskets and scoops	M	SP
Night fishing	<i>Pwto</i> or <i>Mwto Tonam</i>	Fishing with a machete and a bamboo torch	PM	A

PM = Post-monsoon, PRM = Pre-monsoon, W = Winter, M = Monsoon, TTY = Throughout the year, SP = Still practicing, MA = Mostly abandoned, A = Abandoned, B = Banned, OP = Occasionally practicing

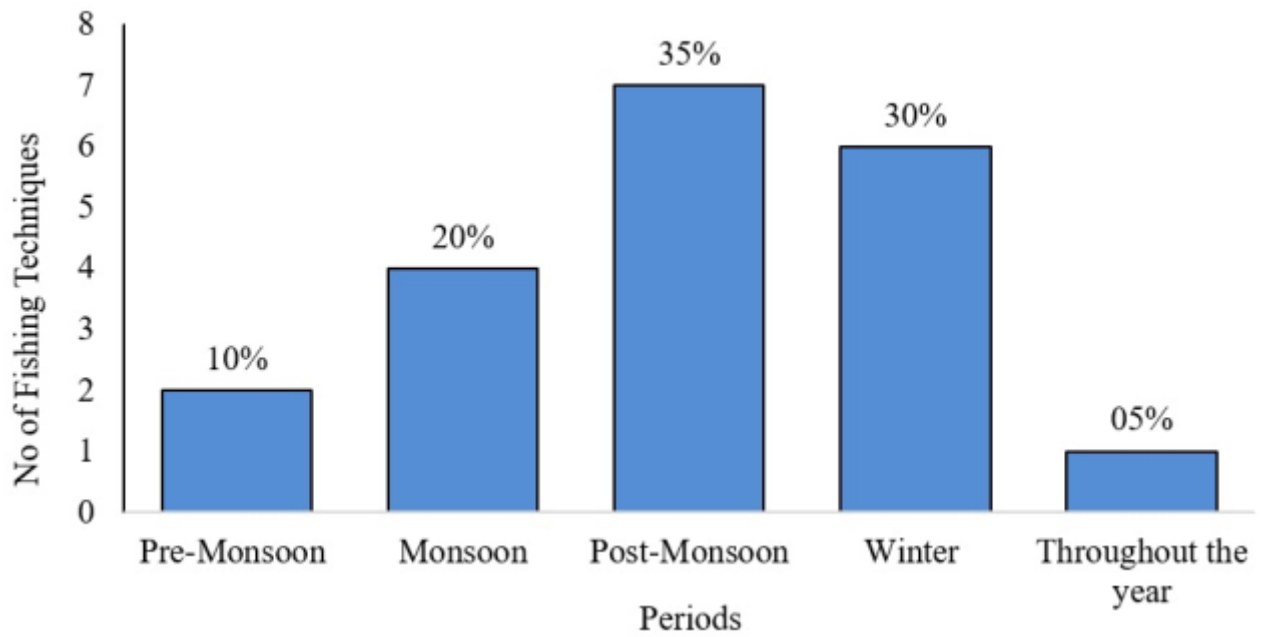


Figure 2. Season-wise number of fishing techniques practiced in the study area

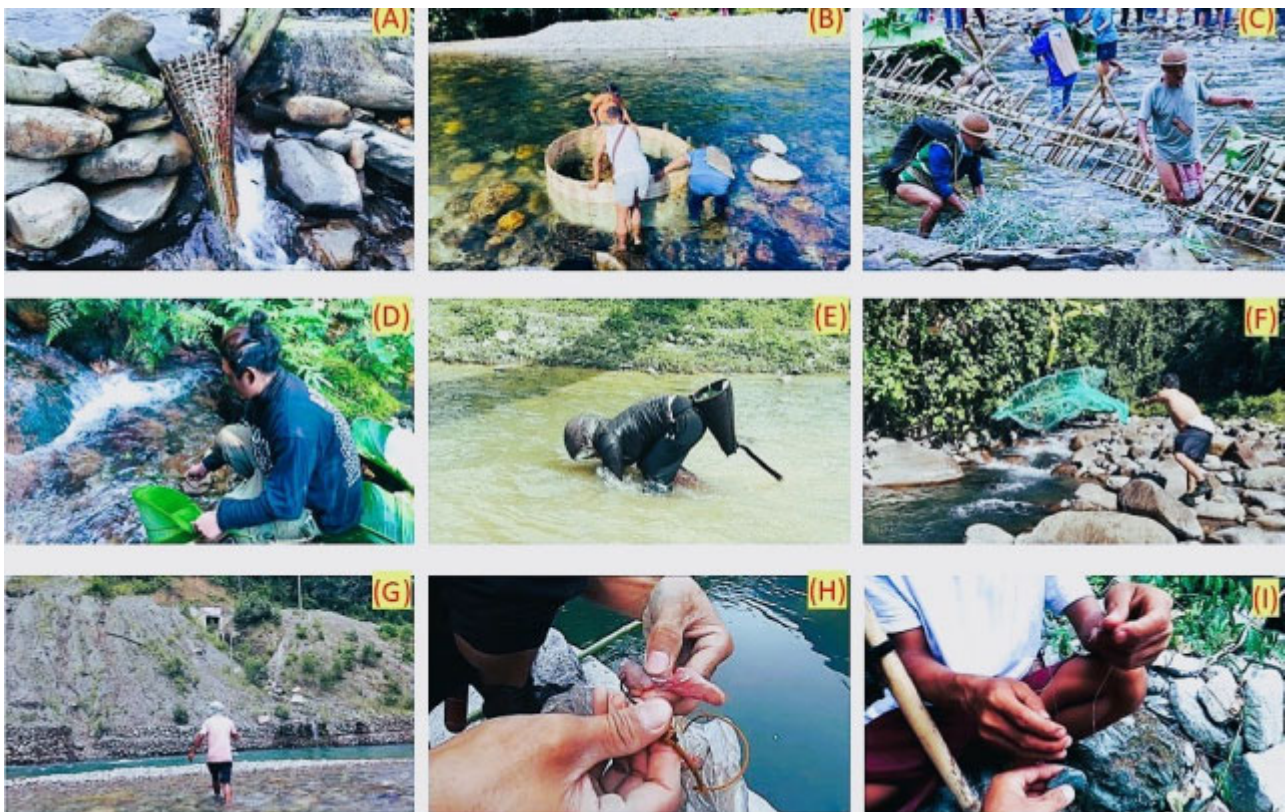


Figure 3. Some of the fishing techniques practiced in the study area

ones in deeper areas, ensuring proper submersion and stability against the current, a key fishing practice. Traditionally, these nets were woven from the bark fibers of a plant known as *Tanw*. Modern versions are made from synthetic fibers. This method can be carried out individually or in small groups and is effective year-round, with the monsoon season being particularly favourable as murky waters help conceal the fishermen. Commonly caught fish using this technique include *Ngotup* (*Garra birostris*), *Ngoru* (*Garra arupi*, *Garra kalpangi*), *Yircho* or *Yirso* (*Tariqilabeo latius*), *Ngori* or *Kada* (*Schizothorax richardsonii*), *Tado* (*Tor putitora*), *Gase* or *Gahe* (*Tor tor*), *Orchi* or *Orse* (*Cyprinion semiplotum*), and *Ngape* (*Bangana dero*). The mesh size is customized to target specific fish species, allowing smaller fish to escape, making it a sustainable technique.

Wounding gears

Hooks and lines: Hooks and lines, locally known as *Vkvr* or *Gvkv* (Fig. 3G), are one of the oldest and most widely practised fishing methods among the Galo people in the study area. Traditionally, they crafted fishing lines from the bark of the *Taro* plant, a fibrous species commonly used for this purpose. For fishing rods, they primarily use specific bamboo species such as *Eajo* or *Vjo* (*Bambusa tulda*) and *Eso* or *Vso* (*Bambusa pallida*). The effectiveness of this method depends heavily on the fisherman's skill, particularly in determining the right timing and utilizing different types of bait. The most favourable period occurs after floodwaters recede and fair weather sets in during the afternoon and evening. The hooks and baits are selected based on the season. During the post-monsoon period, grasshoppers (*Tvkom*) and crickets (*Yvrup* or *Yvruc*) are particularly effective, while earthworms (*Dorkv*), a versatile bait, can be used throughout the year. In the monsoon season, the fruit of *Ficus semicordata* (*Tvkuk*) is preferred, whereas jackfruit (*Artocarpus heterophyllus*, locally known as *Belv*) is commonly used before the monsoon. Additionally, termites (*Taagin*) are used during the early summer months, while ripe wild fruits serve as natural bait in specific seasons. The feeding habits of different fish species, water level, and local ecological knowledge largely influence the selection of baits. Moreover, the effectiveness of this method also depends on the

strategic placement of hooks, ensuring they are positioned in areas with high fish activity, such as near submerged roots, rocky crevices, and shaded pools. This fishing technique includes:

(i) *Kvrci* (Small-sized fish): It is mainly practised by young boys or small children to catch smaller fish species such as *Talo* (*Channa gachua*, *Channa melanostigma*), *Tamv* (*Pterocryptis gangelica*, *Pterocryptis indicus*), *Tayek* (*Amblyceps apangi*), *Tapo* (*Devario assamensis*), and *Orpu* (*Barilius bendelisis*, *Barilius vagra*). The fishing gear, including the rod, line, hooks, and bait, is relatively small. As a result, small baits like earthworms, young locusts, crickets, bamboo maggots, wood maggots, caterpillars, or dragonflies are commonly used. In this method, fish are usually pulled out with a quick jerk, requiring minimal specialized skill. It is practised individually during August and October.

(ii) *Krtv* (Big-sized fish): It is practised from June to August, primarily in large rivers with extensive banks, and is specifically designed for catching large fish species such as *Ngori* or *Kada* (*Schizothorax richardsonii*), *Tado* (*Tor putitora*), and *Gase* or *Gahe* (*Tor tor*). A strong rod, durable line, and sturdy hooks are essential to handle these fish. When a large fish takes the bait, the line should neither be yanked abruptly nor allowed to go slack. Instead, the angler maintains steady tension, keeping the line firm but not overly tight while following the fish's movements. Occasionally, the angler may pull the line sideways to tire the fish. After a prolonged struggle, the fish becomes exhausted and can be carefully drawn to the riverbank and dispatched. The fowl intestines, young featherless birds, young hairless rats, cockroaches, and *Barilius bendelisis* are commonly used as baits.

Still bait fishing: This fishing technique is locally known as *Vkvr rwwnam* or *Ngobv rwwnam*, which means freshwater eel (*Anguilla* sp.) fishing. It is practised between June and September during flooded conditions. However, large fish species such as *Ngape* (*Neolissochilus* sp.) and occasionally *Tado* (*Tor putitora*) are also caught through this technique. This method requires a strong, durable fishing line, sturdy hooks, bait, and a stone to weigh down and stabilize the line. A baited hook is tied to a long fishing line and cast into the water, with a stone fastened in the middle for balance, while the other

end is secured to a tree or large rock. Multiple hooks can be set up in a single day, usually placed after floodwaters recede and checked the following morning or within two days. The fowl intestines, young featherless birds, frogs, small fish, and young hairless rats are commonly used as baits. This method is practised individually with the active participation of only male members.

Spear fishing: Spear fishing (*Ngoi Aabnam* or *Moohap Abnam*) is an ancient fishing technique that involves hunting fish underwater using handheld spears. This method follows the Hawaiian sling style, where a rubber band loop is attached to one end of the spear shaft. It is typically practised from mid-May to October. The band is threaded through a tube, with the other end secured to the tail of the shaft. When a fish is spotted, the fisherman pulls back the rubber band and releases it, launching the spear forward to strike the target. As one of the oldest fishing methods, spearfishing is widely practised for subsistence, recreation, and sport. Fishermen rely on stealth and natural cover to approach their prey undetected, often by holding their breath for extended periods, camouflaging with the underwater environment, and carefully observing fish behaviour. Targeted fish species vary based on location, water conditions, and local fishing regulations. Spear fishing is one of the sustainable fishing practices due to its selective nature, allowing fishers to catch only specific species while avoiding undersized or protected fish. Unlike net fishing or large-scale commercial fishing, this method minimizes bycatch and does not contribute to habitat destruction, making it an environmentally friendly alternative. Additionally, since spearfishing does not require bait, it reduces the risk of unintentionally attracting non-target species or invasive predators. The technique requires skill, patience, and a keen understanding of aquatic ecosystems. In the study area, spear fishing is a means of securing food and is a deeply rooted cultural tradition passed down through generations. The fish caught using this method include *Tado* (*Tor putitora*), *Gahe* (*Tor tor*), *Kada* or *Ngori* (*Schizothorax richardsonii*), *Ngopi* (*Labeo dyocheilus*), *Orse* or *Orchi* (*Cyprinion semiplotum*), *Ngobe* (*Anguilla* sp.), and *Ngape* (*Neolissochilus* sp.). With the advancement of modern technology, equipment such as diving masks, snorkels, and

wetsuits is used to improve the efficiency and safety of spear fishing. Some villages have imposed seasonal restrictions and ethical guidelines to ensure the sustainability of fish populations and the conservation of aquatic biodiversity in the study area. **Jerk fishing:** *Heak hwnam* or *Jatka* does not use bait or poison. It requires a reel, hooks, and a bamboo rod measuring 2 to 3 meters, fitted with multiple rings to guide the fishing line. Two to three hooks are secured at one end of the line, creating an anchor-like structure. The fisherman holds the rod in one hand while using the other to release the line, allowing it to drift downstream with the river's current until it reaches its maximum length. Once extended, the line is reeled in and given a sharp tug. This process is repeated continuously until a fish is successfully caught. Its success is often attributed to the fisherman's patience and luck - some days yield a plentiful catch, while on others, the fisherman may leave empty-handed. This technique primarily targets fish species such as *Ngopi* (*Labeo* sp.), *Gahe* (*Tor tor*), and *Tado* (*Tor putitora*). The technique is recognized as a sustainable fishing practice within the Galo community and is also prevalent among other communities in the state. It is selective, impacting only the targeted fish species while leaving other aquatic life largely unharmed. The technique is primarily carried out from August to October.

Noose fishing

It is locally known as *Ngoi Ognam* (Fig. 3I). This technique is carried out in river sections with strong currents, often characterized by swirling water and visible bubbles from July to September. The equipment used in this technique is similar to that employed in other fishing methods, including a bamboo rod and fishing line. However, unlike conventional methods, this method employs 5 to 10 nooses affixed to the fishing line. At the end of the line, a stone weighing approximately 200 to 300 grams is attached to stabilize the nooses in their position and prevent them from drifting with the current. The nooses are designed to tighten around the fish when they swim through them, effectively capturing the targeted species. This method primarily targets fish species belonging to the genus *Labeo* (locally known as *Ngopi*) and *Garra* sp. (locally known as *Ngotup*). Additionally, species such as

Schizothorax richardsonii (Ngori) and *Semiplotus* sp. (Orche or Orsi) are commonly caught using this technique. It is environmentally friendly as it does not involve any toxic substances. Furthermore, the fish are caught without sustaining significant injury, making it a sustainable and humane fishing practice.

Herbal poisoning

Ritualized fishing: A community-based fishing locally known as *Hentvm* or *Hwwb Rwwnam* is a rare and sacred tradition among the Galo Tribe, deeply intertwined with their cultural and spiritual beliefs. It is performed only in times of crisis, such as plague outbreaks, famine, or other disasters, serving as both a ritual and a means of survival. Before initiating this sacred practice, the villagers must seek guidance through omens to determine whether the expedition should proceed. This divination process involves three traditional methods: *Rokshwn Kokka Nam* (examination of chicken liver), *Pipw Chika Nam* (examination of egg yolk after chanting sacred hymns), and *Ambin Kaka Nam* (examination of rice grain). If the omens are unfavourable, the expedition is postponed until a more auspicious time. It is carried out between August and September, when *Zanthoxylum rhetsa* (*Onyor*), a fish-poisoning plant, is abundant because a large quantity of mature *Zanthoxylum rhetsa* fruit is required. This technique is performed in small to medium-sized rivers without blocking or diverting the water flow. Each household in the village is assigned to collect a basket full of crushed *Zanthoxylum rhetsa* fruit to ensure sufficient poisoning. A medium-sized platform is then constructed over the river, where all the baskets of poison are gathered and released simultaneously. To enhance the poison's effectiveness, local shamans chant sacred hymns, known as *Yebo Chwnam*, near the platform as the poison disperses into the water. These hymns are believed to amplify the potency of the herbal poison. Unlike other fishing methods, this sacred practice is conducted once a decade, typically in response to plagues or calamities. The community members actively participate in this ritual, and the catch is distributed equally among the households. Fish species caught through this method include *Ngotup* (*Garra birostris*), *Ngoru* (*Garra arupi*, *Garra kalpangi*), *Yirchol Yirso* (*Tariqilabeo latius*),

Ngori/ Kada (*Schizothorax richardsonii*), *Tado* (*Tor putitora*), *Gase/ Gahe* (*Tor tor*), *Orchi/ Orse* (*Cyprinion semiplotum*), *Ngape* (*Bangana dero*), *Tayek* (*Amblyceps apangi*), *Ngobe* (*Anguilla* sp.), *Orpu* (*Barilius bendelisis*, *Barilius vagra*), *Talo* (*Channa melanostigma*, *Channa gachua*), *Ngopi* (*Labeo dyocheilus*), *Glyptothorax striatus*, *Olyra praestigiosa*, *Orchin* (*Opsarius barna*), *Parachiloganis paliziensis*, *Pethia conchoniuis*, *Ngoka Pagra* (*Psilorhynchus balitora*), *Pseudecheneis sirenica*, and *Riingum* (*Schistura* sp.). **Plugging stone gaps:** This fishing technique, locally known as *Lwru Hwnam*, is considered one of the most challenging and daring methods, practised in deep, stagnant waters where fish seek shelter under rocks and stones during winter. The diver plunges into the depths to drive fish into crevices, sealing the openings with tree branches and small bamboo mats before capturing them by hand or with a conical fishing trap called *Idir*. Among the various fishing techniques, this is the most perilous, as free divers face significant risks due to prolonged underwater exposure and breathing challenges. Despite these dangers, the abundance of deep-water fish attracts villagers towards this technique, and skilled divers earn recognition and a generous share of the catch. Herbal poisons frequently used in this technique include *Persicaria hydropiper* (*Dikoh Tamw*), *Albizia chinensis* (*Talwk*), *Zanthoxylum rhetsa* (*Onyor*), and *Athyrium filix-femina* (*Rukdwk*), while the bark of *Gynocardia odorata* (*Takv*) is most commonly applied. This method is seasonal and is typically carried out from March to May, just before winter, when fish such as Kalabans (*Bangana dero*), Golden mahseer (*Tor putitora*), Chocolate mahseer (*Tor tor*), and Ghora mach (*Labeo dyocheilus*) take refuge in rock crevices, making them easier to capture with herbal poisons. Besides, this technique is selective, as it targets larger fish, while smaller ones are left unharmed.

Local fish traps

Conical-shaped fish traps: The Galo people use two types of conical-shaped fish traps, i.e., *Tahum* or *Tasum Kunam* (Fig. 3E) and *Rwwgo Goonam*. *Tasum Kunam* is a traditional fishing method practiced exclusively by women, ranging from individual to semi-collective efforts and performed in shallow

waters, between February and March. The primary tool used is the *Raaju*, a conical basket, which the fisher secures between her legs, positioning its mouth against a targeted stone believed to be a fish dwelling spot. By carefully moving or displacing the stone, fish are prompted to dart into the basket, guided by swift and precise hand movements. This method targets various fish species, including *Talo* (*Channa melanostigma*), *Tame* (*Pterocryptis indicus*), *Tayek* (*Amblyceps apangi*), *Riibo* (*Aborichthys boutanensis*), *Ngoru* (*Garra birostris*), *Yircho/ Yirso* (*Tariqilabeo latius*), *Ringum* (*Schistura* sp.), *Tapo* (*Devario assamensis*), *Tasum* (Shrimp), and *Tachi/ Tavci* (Crab).

Rwwgo Goonam is another traditional fishing method primarily practised by women, though men occasionally participate. This collective fishing technique is performed in shallow waters from October to March, during winter when water levels are low. The primary tool used is *Raaju* (a conical basket), which is securely positioned across the river channel facing downstream. The baskets are placed tightly together with no gap to prevent fish from escaping. Once the baskets are set, some participants move downstream and drive fish toward them by shifting stones, inserting sticks between rocks, and tossing stones to startle the fish. The targeted fish species include *Tame* (*Pterocryptis indicus*), *Tayek* (*Amblyceps apangi*), *Riibo* (*Aborichthys boutanensis*), *Ngotup* (*Garra birostris*), *Ngoru* (*Garra arupi*, *Garra kalpangi*), *Yircho/ Yirso* (*Tariqilabeo latius*), *Ringum* (*Schistura* sp.), *Tapo* (*Devario assamensis*), *Tasum* (Shrimp), and *Tachi/ Tavci* (Crab). As fish enter the baskets, they are swiftly lifted to prevent them from escaping. Both techniques are eco-friendly, relying solely on natural ways without toxic substances, ensuring minimal impact on aquatic ecosystems.

Funnel-shaped fish trap: This traditional fishing method is known as *Takom Gaanam* (Fig. 3A). It involves splitting one end of a bamboo pole, approximately 3.5 feet long, into thin strips to widen the mouth, which is then interwoven with additional bamboo splits. Multiple channels are created in rivers with a large cross-section, and a *Takom* (a funnel-shaped fish trap) is placed at the end. Conversely, in narrower rivers, a partial damming technique is sometimes used to direct water to a specific point

while leaving designated passages where *Takom* traps are positioned. As water flows through these passages, fish are carried into the *Takom*, where the force of falling water prevents them from escaping. This fishing method is practised between August and September and is highly selective. The size and type of fish caught depend on the spacing between the bamboo splits in the *Takom*, allowing smaller fish to escape unharmed. Furthermore, this technique is eco-friendly, as it is only employed during the pre-monsoon period and does not involve toxic substances or harmful chemicals. Fish species commonly caught using this method include freshwater eel (*Anguilla* sp.), Lohit snakehead (*Channa melanostigma*), Assamese danio (*Devario assamensis*), Arup's Garra (*Garra arupi*), Beaked Garra (*Garra birostris*), Bareli/ Indian Hill trout (*Barilius bendelisis*), and Kalabans (*Bangana dero*).

Other fishing techniques

Line without a hook: This fishing technique is locally known as *Hoomv*, *Pokam* or *Rwwdv dwwnam* (Fig. 3D). The terms '*Hoomv*', '*Pokam*', and '*Rwwdv*' are derived from the names of three primary fish species commonly caught using this traditional fishing technique - '*Hoomv*' from *Tasum/ Tahum* (Shrimp), '*Pokam*' from *Tapo* (*Danio* sp.), and '*Rwwdv*' from *Riibo* (Stone loach). It is a form of bait fishing practised in small streams that differs from conventional angling. It employs a shorter pole measuring 0.5 to 1.5 meters, a locally crafted fishing line and a conical funnel, primarily made from the *Phyrinium* sp. (*Okw* or *Ekkam*). The bait consists mainly of *Tanyi* (worms extracted from bamboo), though *Dorka* (earthworms) are sometimes used. The primary fish species targeted include *Talo* (*Channa melanostigma*, *Channa gachua*), *Tame* (*Pterocryptis indicus*), *Tayek* (*Amblyceps apangi*), *Riibo* (*Aborichthys boutanensis*), *Tasum* (Shrimp), and *Tachi/ Tavci* (Crab). Conducted seasonally between October and March, this fishing practice actively involves both men and women. Notably, it is free from intoxicants or harmful substances, ensuring an environmentally sustainable approach that preserves aquatic life.

River course diversion: Hibok Pwnam (Fig. 3C) is a traditional technique practised by the Galo community of Arunachal Pradesh, between April and

August. This technique is used in fast-flowing streams, where the water is temporarily diverted into a smaller channel by constructing a makeshift dam using locally available materials such as mud, rocks, boulders, plants, and wild banana leaves. The diversion isolates fish within a confined area, and once the water is drained, they can be easily caught by hand. If the obstruction is not entirely secure, indigenous poisonous herbs are applied to stun the fish, making them easier to capture. The herbal poison is derived from leaves, fruits, or bark of plants such as *Persicaria hydropiper* (*Dikoh Tamw*), *Albizia chinensis* (*Talik*), *Zanthoxylum rhetsa* (*Onyor*), *Athyrium filix-femina* (*Rukdik*), and other plants of the Fabaceae family. When these plant materials are crushed with sand and introduced into the water, they release a natural toxin that temporarily stuns the fish, allowing them to be collected within a few minutes. If any fish survive the poisoning, a conical trapping basket, made from locally sourced materials, is used to catch them. The effectiveness of herbal poisoning is limited by both time and distance. The toxin remains active for about 3 to 4 days, with an estimated range of 1.5 to 2.5 km from the diversion point to the endpoint of the diverted river. However, its potency also depends on water discharge levels. This method is considered sustainable, as the river quickly becomes habitable again for aquatic life due to the biodegradable nature of the herbal poison. However, some locals have begun using bleaching powder, which poses environmental concerns. Fish caught through natural methods remain safe for human consumption. The commonly harvested species include *Ngotup* (*Garra birostris*), *Ngoru* (*Garra arupi*, *Garra kalpangi*), *Yircho/ Yirso* (*Tariqilabeo latius*), *Ngori/ Kada* (*Schizothorax richardsonii*), *Tado* (*Tor putitora*), *Gase/ Gahe* (*Tor tor*), *Orchi/ Orse* (*Cyprinion semiplotum*), *Ngape* (*Bangana dero*), *Tayek* (*Amblyceps apangi*), *Ngobe* (*Anguilla* sp.), *Orpu* (*Barilius bendelisis*, *Barilius vagra*), *Talo* (*Channa melanostigma*, *Channa gachua*), *Ngopi* (*Labeo dyocheilus*), *Glyptothorax striatus*, *Olyra praestigiosa*, *Orchin* (*Opsarius barna*), *Parachiloglanis paliziensis*, *Pethia conchoniensis*, *NgokaPagra* (*Psilorhynchus balitora*), *Pseudecheneis sirenica*, *Riingum* (*Schistura* sp.), as well as crabs and shrimps.

Lured fishing techniques: The Galo tribes use two

types of lured fishing techniques, i.e., *Hipw Tumnam* and *Hipv Panam*. *Hipw Tumnam* is a traditional fishing method that involves damming a section of a stream at both ends, creating an enclosed area where fish are encouraged to gather. Within this confined space, fish are regularly fed with natural baits such as millets (*Tami*), rice leftovers (*Chinka*), maize (*Teffe*), and the residue of brewed rice beer (*Poyee*). The consistent feeding conditions allow the fish to return to the same spot, making them easier to catch once a sufficient number has assembled. Once the fish population within the enclosure reaches an optimal level, the water is gradually drained, leaving the fish trapped in a conical trapping basket called *Idir*. This method is highly effective due to the fish's habitual association with the site, ensuring a steady yield. The fish mostly caught using this method are *Talo* (*Channa gachua*, *Channa melanostigma*), *Tamv* (*Pterocryptis gangelica*, *Pterocryptis indicus*), *Tayek* (*Amblyceps apangi*), *Tapo* (*Devario assamensis*), *Orpu* (*Barilius bendelisis*, *Barilius vagra*), shrimp, and crabs. Unlike many other fishing techniques, this practice is inclusive, engaging men, women, and children alike, making it a semi-collective to collective activity. It fosters a sense of cooperation and strengthens social bonds as families and neighbours work together. The method is practised during winter, particularly between October and March, when water levels are lower and easier to manage. The success of this technique largely depends on the type of bait used, as different fish species are attracted to various food sources. It is a sustainable technique as no toxic substances or harmful chemicals are used, ensuring that non-targeted aquatic life remains unharmed. Additionally, this method has been passed down through generations, serving not only as a means of subsistence but also as a vital cultural tradition that preserves indigenous fishing knowledge and reinforces community ties.

Another lure fishing technique is locally known as *Hipv Panam*. This fishing technique involves constructing a barrier made from wood, cane, bamboo, and wild banana leaves across a stream to channel the water flow into a designated gap known as the *Hiree*. Bamboo traps are strategically positioned to capture fish as they move downstream with the current. Designed to blend seamlessly with

the natural river environment, this structure minimizes disruption to aquatic life. The *Hiree* is placed at a 90-degree angle to the main dam, called *Hipv*, optimizing fish collection. To facilitate the collection of the trapped fish, a secondary platform known as *Regu* or *Rego* is attached to the *Hiree*, ensuring easy collection while preventing fish from escaping back into the stream. The construction of the *Hipv* is labour-intensive, requiring collective effort from community members. Those responsible for harvesting the fish visit the site regularly, often early in the morning, to collect the catch before water levels rise. The targeted fish species include *Ngape* (*Neolissochilus* sp.), *Gahe* (*Tor tor*), *Tado* (*Tor putitora*), *Ngobe* (*Anguilla* sp.), and *Ngopii* (*Labeo dyocheilus*), among others. A key advantage of this method is its sustainability, as it does not rely on artificial chemicals or herbal poisons, thus preserving the natural ecosystem. The bamboo traps allow smaller fish to escape, promoting fish population growth and maintaining ecological balance. The effectiveness of the technique depends on water flow, seasonal variations, and the proper upkeep of the *Hipv* and *Hiree*. The dry season is the most favourable period due to lower water levels, making fish movement easy to control. Deeply embedded in local traditions, this practice has been passed down through generations as both a subsistence technique and a cultural heritage, fostering community collaboration as individuals work together to construct, monitor, and maintain the fishing structures. Beyond its practical benefits, it serves as an educational tool for younger generations, ensuring the preservation of indigenous knowledge on sustainable fishing. Over time, modifications and improvements have been introduced to enhance its efficiency while maintaining its environmentally friendly approach. This method is primarily practiced between October and March.

Stone heap fishing: The Galo community employs a traditional fishing technique called *Lwwpum* (Fig. 3B) to catch bottom-feeding fish (*Garra* sp.) during winter. This method involves constructing a circular stone enclosure in shallow, still waters, with a diameter of 1.5 to 2.3 m and a height of 0.7 to 1.2 m, depending on the water depth. Each family typically manages a designated section of the river for *Lwwpum* fishing. The structure is strategically placed

during the rainy season when water levels are high to ensure it remains submerged, making it unsuitable for fast-flowing streams. The construction involves clearing and slightly depressing the riverbed with one's feet before stacking stones of various sizes. A flat stone known as *Koodo* is placed at the center, believed to attract fish. Proper arrangement of stone is essential for a successful catch, with some gaps left open for fish to enter, while others are sealed with gravel and pebbles to limit sunlight exposure. In some cases, branches are used as an additional cover to reduce light penetration. Once constructed, it serves as a refuge for fish, fostering algae growth and slowing water movement within the structure. When harvesting, fishermen enclose the *Lwwpum* with an *Ishir* or *Ichir* (a bamboo mat encircling gear) with an opening at the top, while an *Idir* is placed at the bottom to prevent fish from escaping. Commonly caught species include freshwater eel (*Anguilla* sp.), Lohit snakehead (*Channa melanostigma*), Assamese danio (*Devario assamensis*), Arup's Garra (*Garra arupi*), Beaked Garra (*Garra birostris*), Bareli/Indian Hill trout (*Barilius bendelisis*), Indian Torrent Catfish (*Amblyceps apangi*), Vagra baril (*Barilius vagra*), Striped Torrent Catfish (*Glyptothorax striatus*), Deceptive Olyra Catfish (*Olyra praestigiosa*), Fringe barbs (*Tariqilabeo latius*), and Loach (*Schistura* sp.). The preparation of *Lwwpum* is typically undertaken by men between September and November, while fishing occurs from late December to early January. The fish are collected by gradually dismantling the stone structure. It is a sustainable fishing technique for subsistence communities such as the Adis and Galos. While the fundamental technique remains unchanged, specific materials, viz., mosquito nets, have evolved to replace the traditional *Ishir*, which are more efficient and convenient. Importantly, *Lwwpum* fishing does not involve toxic substances, making it an environmentally friendly and safe practice for aquatic ecosystems.

Bare-hand fishing: This traditional fishing technique is locally known as *Lwwruu Iinam*, primarily practised by young men in the community. It involves catching fish barehanded without the aid of any supplementary fishing tools. Fishermen carefully reach into crevices between boulders, where fish are likely to take shelter, and capture them directly. The

species caught using this technique vary depending on the location, river depth, and seasonal conditions. Most of the fish caught are *Talo* (*Channa gachua*, *Channa melanostigma*), *Ngoru* (*Garra arupi*, *Garra kimini*, *Garra kalpangi*), *Ngotup* (*Garra birostris*), *Tame* (*Pterocryptis gangelica*, *Pterocryptis indicus*), etc. This technique can be performed individually or in small groups, fostering teamwork and cooperation. It is effective during the pre-monsoon season in rivers with rapids. The boulders provide natural hiding spots for fish. The technique can also be practised at night under a full moon, as increased visibility in the water may aid in locating fish. This technique is an environmentally friendly approach that helps preserve aquatic ecosystems. Unlike other fishing techniques that may require specialized gear or external resources, this method relies solely on skill, experience, and intuition, making it a test of patience and agility. Typically carried out in shallow waters, this method poses minimal risk of drowning and is most commonly practised during April to June. It is a cultural tradition passed down through generations that reinforces ancestral knowledge and strengthens community bonds. Some fishermen also incorporate observational skills, such as reading water currents and fish behaviour, to improve their chances of success.

Floodwater fishing: Ngouu or Ngoru Lanam is a traditional fishing technique practised from June to July, coinciding with the onset of the monsoon and the breeding season of *Ngoru* (*Garra* sp.). Once floodwaters rise, fish migrate through irrigation channels and shallow streamlets into inland ponds and paddy fields to spawn. This seasonal movement of fish presents an opportune moment for fishing, as the fish begin their return journey to the main river after laying eggs. The targeted fish include *Ngoru* (*Garra arupi*, *Garra kimini*, *Garra kalpangi*), *Ngotup* (*Garra birostris*), *Riingum* (*Schistura* sp.), and *Tamv* (*Pterocryptis gangelica*, *Pterocryptis indicus*), etc. To capitalize on fish migration, intricately woven basket traps are strategically placed along key escape routes to intercept and capture the fish. In addition to these traps, fish are gathered manually - either by hand or using a traditional fish-scooping tool called a *Wdwr*. Fishing baskets are carefully positioned in irrigation canals and along the edges of bunds, where surplus water drains

through natural openings, ensuring an efficient and sustainable catch. On the outskirts of wet rice fields, some communities designate specific sections of small streams, locally known as *Ngou Paataa*, as dedicated fishing zones during the season. It is a semi-collective to collective method that requires coordination and cooperation among the community members. Both men and women actively participate, from crafting and setting traps to monitoring fish movements and harvesting the catch. Beyond its practical function, this fishing technique is deeply rooted in cultural traditions, fostering social cohesion and preserving ancestral knowledge. One of the greatest strengths of *Ngouu* or *Ngoru Lanam* is its sustainability. The method relies on natural fish migration patterns and minimizing environmental disruption. Additionally, because this technique primarily targets fish after spawning, it helps sustain breeding populations, contributing to the long-term health of aquatic ecosystems.

Night fishing: Pwto or Mwto Tonam is one of the most distinctive traditional techniques, primarily carried out at night between October and March, using a machete and a bamboo torch, locally known as *Mwto* or *Pwto*. The torchlight is vital in attracting fish, particularly species from the catfish family and *Channa*, *Tor*, and *Barilius* families, luring them toward the fishermen for an easy catch. This technique requires at least two individuals, typically men - one carrying the bamboo torch to illuminate the water and draw fish in, while the other swiftly strikes with a machete. Additional participants may assist in handling the catch or providing backup lighting, making it a semi-collective practice. Its success depends on water clarity, the intensity of the torchlight, and the fisherman's skill in timing their strike. It is most effective in shallow water bodies such as streams, riverbanks, and flooded fields where fish gather at night. A key advantage of this method is its sustainability, as it does not rely on artificial baits, nets, or poisons, minimizing environmental impact. More than just a livelihood, this practice reflects the deep-rooted fishing traditions of the community, showcasing their ingenuity in utilizing natural resources for subsistence while also serving as a cultural tradition that strengthens social bonds and preserves indigenous knowledge.

DISCUSSION

Traditional fishing techniques have been practised for centuries by indigenous communities worldwide, reflecting a deep understanding of local ecosystems and sustainable resource management. These methods often rely on naturally available materials, selective harvesting, and seasonally regulated fishing practices that minimise the ecological impact (Berkes et al. 2000). Unlike modern industrial fishing, which can lead to overfishing and habitat destruction, traditional fishing techniques are often designed to ensure the long-term viability of fish populations (Johannes 1978). Many indigenous fishing methods are also community-based, fostering social cohesion and knowledge transfer across generations (Gadgil et al. 1993). By integrating these time-tested techniques with modern conservation policies, sustainable fisheries management can be enhanced, promoting both biodiversity conservation and the livelihoods of traditional fishing communities (Anonymous 2012). Many studies have been conducted regarding the traditional fishing techniques of different tribes of Arunachal Pradesh, such as Nocte (Dutta and Dutta 2013, Dutta et al. 2019), Nyishi (Tana et al. 2014), Adi (Singh et al. 2016), Galo (Karga et al. 2020, Noshi 2020), etc.

The study on the indigenous fishing techniques of the Galo tribe in Arunachal Pradesh presents a compelling case for the role of traditional ecological knowledge in sustainable fisheries management. Fish traps are passive fishing devices made of suitable hard or soft structures to trap fish that are attracted in for food or security (Nissa and Lekshmi 2021). One of the most striking aspects of the Galo fishing techniques is their alignment with sustainable fishing principles. Methods such as *Takom Gaanam* (a funnel-shaped bamboo trap), *Lwwpum* (stone heap fishing), and *Rwwgo Goonam* (drive fishing with a conical cane basket) demonstrate selective fishing approaches that minimise bycatch and allow juvenile fish to escape, thereby supporting fish population stability (Ruddle and Hickey 2008). Moreover, the avoidance of non-biodegradable materials and reliance on locally sourced, eco-friendly fishing gear ensures minimal environmental disruption.

However, certain practices such as *Lwwruu Iinam* (fishing by plugging stone gaps with herbal poison)

and *Hibok Pwnam* (river course diversion) raise ecological concerns. While these methods employ natural plant-based poisons, the potential impact on non-target species and aquatic food webs warrants further examination (Hussain et al. 2016). Nevertheless, the limited seasonal application of these methods and the rapid degradation of herbal toxins mitigate long-term environmental harm compared to synthetic chemicals. Fishing with locally available herbs and plants is a traditional technique in the study area and the state. Leaves, fleshy parts covering seeds, stems, and roots of plants, are used for fish poisoning. These plants include *Persicaria hydropiper*, *Spilanthes oleracea/Acmella oleracea* (Paracress), and *Zanthoxylum rhetsa*. Various studies have also reported the use of these plants by different tribes in Arunachal Pradesh (Tag et al. 2005, 2015, Namsa et al. 2011, Nimasow 2012, Wangpan et al. 2019, 2023).

The study underscores the deep cultural significance of fishing among the Galo people. Ritualized fishing (*Hentvm* or *Hwwb Rwwnam*) illustrates the integration of fishing practices with spiritual beliefs and community bonding (Karga et al. 2020). Furthermore, gender-specific roles, such as *Tasum Kunam* (a fishing method practised exclusively by women), reflect the social structure and equitable participation in resource harvesting (Beveridge et al. 2013). Fishing serves as a subsistence activity and also fosters intergenerational knowledge transfer. Traditional techniques passed down through generations contribute to cultural identity while ensuring that fishing remains a sustainable livelihood option. The semi-collective and collective nature further reinforces community cohesion and resource-sharing principles, which are critical for resilience in indigenous societies (Hanazaki et al. 2013). Given the growing threats of overfishing, habitat degradation, and climate change, indigenous fishing techniques offer valuable insights into low-impact fisheries management (Lynch et al. 2016). Policymakers and conservationists can benefit from integrating traditional knowledge with modern conservation strategies. Recognition of these practices within the framework of community-based fisheries management could lead to policy formulations that can balance cultural preservation with biodiversity conservation (Anonymous 2018).

Furthermore, documentation and awareness programs highlighting sustainable indigenous techniques can contribute to broader conservation efforts. By promoting eco-friendly fishing methods and discouraging unsustainable practices, local authorities and environmental organizations can support both ecological integrity and the livelihoods of indigenous communities (Mohanty et al. 2015). The indigenous fishing techniques of the Galo tribe exemplify a harmonious relationship between human societies and aquatic ecosystems. Their techniques reflect a wealth of ecological knowledge, refined over centuries through observation and adaptation. While most of these techniques align with sustainability principles, ongoing efforts are desirable to address potential concerns associated with some practices. By acknowledging and integrating these traditional approaches into modern conservation frameworks, a balanced pathway for sustainable fisheries management can be established, ensuring the continued coexistence of cultural heritage and environmental stewardship.

CONCLUSION

The rivers and streams in the study area vary in topography and water flow. To adapt to this environment, local people have developed diverse indigenous fishing tools and techniques to sustain their livelihood and food security. The study documented sixteen traditional fishing techniques, including impaling devices, hooks and lines, and traps. Made mainly of available materials such as canes, wood, and bamboo, these least-cost tools are designed to withstand the local environment. Traditional fishing remains vital to the cultural life of the people. The effectiveness of various fishing techniques is influenced by factors such as site selection, timing, gear efficiency, fish availability, water depth, seasonal variations, river flow dynamics, habitat type, and the expertise of the fishermen. Moreover, environmental elements such as weather conditions, water clarity, and aquatic vegetation also significantly impact the efficacy of traditional fishing techniques. However, with time, destructive practices such as chemical poisoning, dynamiting, and electro-fishing are becoming extensive, threatening fish populations and

biodiversity. These harmful methods are increasingly used to maximize catch with minimum effort, disregarding their long-term impact on fish populations, aquatic ecosystems, and biodiversity. Such harmful practices should be strictly banned, and eco-friendly indigenous fishing practices must be encouraged to conserve fish diversity. Hence, sustainable fishing practices and well-designed gear are crucial for responsibly preserving fishery resources in the study area.

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