Cats Fishing. Modeling The In-Game Economy

404 Dynamics

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Contents

1 Introduction

Disclaimer:

This document may contain forward-looking statements regarding the future development and features of the Cats Fishing platform. Such statements are based on current expectations and are subject to change without notice. No reliance should be placed on these forward-looking statements as the actual outcome may differ materially due to technical, regulatory, or market factors. The $BONE token is intended solely for in-game use and utility. It does not represent any form of equity, ownership, or investment interest in Cats Fishing or any affiliated entity. Cats Fishing does not operate an exchange, and any external trading by participants occurs solely through third-party platforms beyond the project's control. *The information in this document is provided for informational purposes only. Nothing herein constitutes legal, financial, business, or investment advice, and you should not treat any of the content as such. Cats Fishing and its token ($BONE) are designed primarily for in-game utility and entertainment. There is no guarantee of future value, profitability or liquidity for participants. Participation may be restricted in certain jurisdictions and certain features, token distributions, or geographic availabilities described herein may be subject to change to ensure ongoing compliance with applicable laws. This document may contain forward-looking statements regarding the future development and features of the Cats Fishing platform. Such statements are based on current expectations and are subject to change without notice. No reliance should be placed on these forward-looking statements as the actual outcome may differ materially due to technical, regulatory, or market factors. The $BONE token is intended solely for in-game use and utility. It does not represent any form of equity, ownership, or investment interest in Cats Fishing or any affiliated entity. Cats Fishing does not operate an exchange, and any external trading by participants occurs solely through third-party platforms beyond the project's control. We are actively monitoring applicable laws and regulations and are committed to adhering to applicable legal frameworks. However, players are responsible for understanding and complying with the laws of their respective jurisdictions when participating in the Cats Fishing game.*

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Cats Fishing is a multiplayer fishing game, where anyone can go fishing on several virtual islands, collect and build exciting items, and meet new friends. Inspired by successful games such as Animal Crossing, the game combines the best of both worlds—a fun narrative for regular players who want to enjoy the gameplay experience, as well as a blockchain-enabled in-game economy for those who enjoy collecting NFTs.

The game is aimed at a diverse gaming community and can be easily accessed from regular platforms. Our main comparison lies within the traditional gaming market with the same core audience. We are innovating an unobtrusive way of connecting an exciting game narrative to blockchain features. *Cats Fishing has the potential to attract a large community of gamers, providing an engaging in-game economy that rewards player skill, creativity, and strategic decision-making. All references to 'rewards' refer solely to in-game items, tokens, or other progression benefits.*

In this document, we focus on describing the models and mechanisms for the in-game economy of *Cats Fishing*. As discussed later, this involves various protocols and computations designed to keep gameplay both fun and balanced. Our ultimate goal is to design in-game mechanisms that are enjoyable for all types of players, while striving for a robust in-game economic design that maintains the integrity of the gaming experience over speculative interests.

1.1 Why this?

Disclaimer *While Cats Fishing draws on lessons from previous Web3 games, we are committed to working within applicable legal frameworks. Mechanisms described here are intended to enhance gameplay and user experience, not to encourage speculative trading.*

The design of token economics in gaming ecosystems represents a critical frontier in the evolution of digital entertainment and virtual economies. Indeed, while blockchain gaming promises to revolutionize player ownership and value creation, historical evidence demonstrates both the potential and pitfalls of token-based gaming economies. Traditionally, one could argue that Web3 as a whole has been rather driven by short-term profitability (e.g., having users *dumping* their token shortly after they're received), however, this is a behavior that mechanism designers can attempt to correct by introducing sufficiently robust incentives to behave in a desired way. As such, the success of these systems hinges on careful economic design that prioritizes sustainable player engagement over short-term speculation.

Indeed, early attempts at gaming *tokenomics*, such as *Axie Infinity's* [Tea21] initial model, highlighted the vulnerabilities of yield-focused designs. During its peak in 2021, Axie Infinity achieved a market capitalization exceeding $8 billion, with over 2.7 million daily active users [XHWZ24]. However, the ecosystem's heavy reliance on continuous player growth and unsustainable yield mechanisms led to a significant market correction, demonstrating the importance of balanced economic design.

In contrast, more sustainable models have emerged from platforms that prioritize gameplay experience while incorporating token mechanics as complementary features. Analysis of successful blockchain games reveals that sustainable token economies require careful balance between value accrual and value creation mechanisms [XCGM22]. These findings from empirical studies of early blockchain games suggest that token economics must be designed as an extension of compelling gameplay rather than as the primary driver of player engagement.

For Cats Fishing, these lessons emphasize the importance of designing token mechanics that enhance the core fishing and collection mechanics while avoiding the common pitfalls of over-financialization. The game's focus on accessibility and traditional gaming audiences aligns with successful approaches observed in the market, where blockchain features serve to augment rather than define the player experience [RS23].

This white paper outlines our approach to creating a balanced token economy that supports both casual players and engaged collectors[1] while maintaining long-term sustainability. Through careful mechanism design and targeted utility functions, we aim to demonstrate how blockchain technology can enhance rather than disrupt traditional gaming experiences.

[1] *Engagement here is to be understood solely in terms of in-game progression and enjoyment*

1.2 Core Mechanics

Cats Fishing combines three core systems: *fishing game play, item collection & management*, and an *in-game economy* based on the game's native currency: the $BONE token. All of these systems are designed with sustainable and robust token economics in mind. Players engage with these systems through their cat characters, making strategic decisions about catching, storing, and trading fish while managing resources and progression. Each system is carefully balanced to create engaging gameplay loops that reward the player's loyalty to the game. In this subsection, we will explore these components in more detail.

Game Play The core mechanism of the game is fairly simple: Cats go and fish, and when they catch something, they can either take it to the marketplace to sell the fish, or to the restaurant/fish monger to have it cooked. Naturally, cats need to eat, otherwise their Health Points (HP) will decrease; however, in *Whiskery Woods*, cats can't eat raw fish – it needs to be cooked. Thus, whenever a cat catches a fish, they need to decide whether they want to sell it or eat it. It is worth mentioning that players can catch and store multiple fishes at any given point. The HP management system serves as a crucial economic stabilizer by creating consistent token demand through necessary gameplay activities. Players must regularly purchase cooked fish from restaurants using $BONE tokens to maintain their HP levels, which are consumed during fishing activities. The HP consumption rate increases with more advanced fishing activities, creating a natural balance between earning potential and maintenance costs. This system helps maintain token velocity while preventing excessive accumulation by requiring regular expenditure for continued participation.

Remark. *While $BONE may be used in third-party marketplaces or traded between players, Cats Fishing does not operate any such external exchange or provide guarantees regarding liquidity or pricing.*

Token Economy The token is supported through multiple interconnected economic mechanisms. On the supply side, sophisticated algorithms manage resource availability through dynamic adjustment of catch rates and population regeneration. The catching rate $\mu_I(t)$ responds to current fish populations and player activity levels, creating natural scarcity when needed while ensuring sufficient resources for active gameplay. This is complemented by the birth process $\lambda_I(t)$, which manages resource regeneration based on current population levels and carrying capacity. This is discussed in more detail in Section 3.

Fish prices follow carefully designed pricing functions that incorporate both exponential and constant elasticity models. These functions respond to supply levels and market conditions, ensuring that prices in $BONE tokens accurately reflect resource scarcity while maintaining economic stability. The pricing model includes parameters for both immediate market conditions and longer-term trends, creating a balanced and predictable economic environment. This is further discussed in Section 4.

Item Collection and Management The equipment progression system forms a central pillar of token utility. Here, players begin with basic fishing gear and progressively upgrade their equipment using $BONE tokens earned through gameplay. Each tier of equipment unlocks new fishing capabilities, access to more valuable fish species, or improved efficiency in existing activities. This progression system is carefully balanced to ensure that investments in better equipment translate to proportionally improved earning potential, maintaining the value proposition at each tier of progression.

The marketplace severs as a means for player to e.g., buy their fish, as well as equipment, in-game items, etc. All in-game marketplace activities occur in $BONE tokens, creating a closed economic loop that maintains token utility. The marketplace incorporates sophisticated pricing mechanisms that account for multiple variables including supply levels, item rarity, and market demand. Special items and rare catches can be tokenized as NFTs, adding another layer of value and trading opportunities within the ecosystem. Economic Value Drivers.

1.3 Organization

The rest of this document is structured as follows. In Section 2 we outline the core components of the token economy. Here, we begin by mapping the key stakeholders, and discuss the key value drivers of the economy. In Section **??**, we present a potential distribution mechanism for the $BONE token. In Section 3 we present the proposed mechanism for how fishes are caught and appear in the game, and in Section 4, we discuss how these fishes are priced within the game. As we will see, both of these mechanisms will in turn depend on several "global" parameters, such as the number of players, their activity, etc. Lastly, in Section 5, we discuss how players can level up in the game, and why they are incentivized to do so. The rest of the in-game documentation can be found in [Tea24].

2 The $BONE Token Economy

The *Cats Fishing* economy is built around the $BONE token, which serves as the primary in-game medium of exchange within the platform's ecosystem. This section outlines the token's purpose, its utility in gameplay, and the mechanisms designed to support long-term stability and player engagement. We begin by describing the main stakeholders in the *Cats Fishing* economy.

2.1 Token Use Cases and Economic Flows

The $BONE token underpins *Cats Fishing*'s various economic interactions, weaving together player actions, resource management, and in-game progression. Below, we discuss its key uses and the core economic flows that sustain player engagement.

2.1.1 Resource Generation and Primary Economic Activities

The fundamental economic activity within Cats Fishing centers around the fishing mechanic, where players engage with the game's primary resource generation system. Players participate in fishing activities that require skill, strategy, and resource management. Each fishing expedition presents opportunities to catch various species of fish, with different varieties holding distinct values based on their rarity, attributes, and current market conditions.

The fishing system incorporates sophisticated mechanics that consider multiple factors including player skill, equipment quality, location selection, and timing. More skilled players who invest in better equipment and develop efficient strategies can access higher-value fishing opportunities, creating a natural progression system that rewards dedication and strategic thinking. This core gameplay loop establishes the foundation for all subsequent economic activities within the ecosystem.

2.1.2 Token Earning Mechanisms

Players earn $BONE primarily by selling their catches to **in-game restaurants**. These restaurants apply dynamic pricing algorithms that adjust based on supply-demand conditions inside the game. Ideally, each such in-game transaction is subject to some nominal fee (a percentage $\varphi_{\text{restaurants}}$ of the traded amount). This amount would then go to the game treasury. Once in the treasury the community could decide, via standard governance mechanisms, what to do with these tokens (e.g., burn them, use them for ecosystem development, etc).

Fish pricing follows sophisticated formulas that incorporate both immediate market conditions and longer-term trends. When certain fish species become scarce due to increased catching activity, their value in $BONE tokens automatically adjusts upward, creating natural market dynamics that reward strategic resource gathering. Conversely, abundant fish species may see price decreases, encouraging players to diversify their fishing activities and maintain ecosystem balance.

Notice that while players may earn $BONE through gameplay, these mechanics are designed solely for in-game engagement and utility. $BONE is not intended to hold monetary value or generate real-world financial returns

2.1.3 Token Expenditure Systems

To keep the in-game economy dynamic and stable, *Cats Fishing* implements multiple "token sinks" that encourage ongoing spending of $BONE . The result is a balanced cycle of earning and spending.

Equipment and Progression System The equipment marketplace represents a primary token sink within the economy. Players can upgrade from basic rods to advanced gear, opening up more efficient or rewarding fishing opportunities. Players can upgrade from basic rods to advanced gear, opening up more efficient or rewarding fishing opportunities. Higher-tier equipment is priced in $BONE , creating a natural loop where earned tokens are spent to improve gameplay, rather than idle or speculate. Ideally, these transactions should also subject to some nominal fee (a percentage $\varphi_{\text{equipment}}$ of the traded amount). This amount wold then go to the game treasury.

Health Point (HP) Management The HP system serves as another crucial token sink, creating consistent demand through necessary gameplay maintenance activities. Players must manage their characters' HP levels by purchasing prepared fish dishes from restaurants using $BONE tokens. This mechanic introduces a strategic element to resource management, as players must balance their earnings between progression investments and sustained gameplay activities.

The HP consumption rate scales with activity level and fishing location difficulty, creating a natural balance between earning potential and maintenance costs. More challenging fishing activities that offer higher rewards also typically require greater HP investment, maintaining the risk-reward ratio across different player segments.

Economic Feedback Loops The interaction between these various systems creates multiple reinforcing feedback loops that drive sustained economic activity. When players invest in better equipment, they gain access to more profitable fishing opportunities. These increased earnings can then be reinvested in further equipment upgrades or used for HP maintenance, creating a sustainable cycle of economic activity.

This feedback system is carefully balanced to ensure that investments in progression provide meaningful returns while maintaining overall economic stability. The relationship between investment costs and potential returns is continuously monitored and adjusted through sophisticated algorithms that consider multiple economic indicators including catch rates, token velocity, and market prices.

Market Dynamics and Price Discovery All these economic activities contribute to natural price discovery mechanisms within the ecosystem. The constant flow of tokens between earning and spending activities, combined with dynamic pricing algorithms, ensures that token value reflects true market conditions while maintaining stability. The system implements various economic controls to prevent market manipulation and ensure sustainable value creation. These include rate limiting on certain activities, dynamic pricing adjustments based on volume, and sophisticated monitoring systems that track key economic indicators. Through these mechanisms, the economy maintains balanced token flows while providing clear value propositions for all participants.

Through this comprehensive system of economic activities, the $BONE token establishes itself as both a medium of exchange and a store of value within the Cats Fishing ecosystem. The careful balance between token sources and sinks, combined with sophisticated price discovery mechanisms and progression systems, creates a sustainable economic environment that rewards strategic gameplay while maintaining long-term stability.

2.2 Value Accrual Mechanisms

The design of value accrual mechanisms in *Cats Fishing* is focused on ensuring a self-sustaining and engaging in-game economy. These mechanisms are intended to balance gameplay progression with the utility of the $BONE token. The token's value is derived solely from its continuous use within the game, thereby reinforcing player engagement and overall ecosystem stability.

One key component is the transaction-based in-game value mechanism. Every transaction made **within the game**—whether it involves purchasing equipment, in-game objects, or cooked fish incurs a small fee. These fees will, in principle go to the in-game treasury, where their use may be determined by governance mechanisms as they develop. A portion of the fees is allocated to periodic token burns, which create a deflationary pressure by reducing the overall token supply, while another portion is dedicated to funding ongoing improvements and special community events. The objective of this mechanism is to enhance the quality of the gameplay experience by ensuring that tokens continuously circulate within the ecosystem.

Another important component is the integration of staking and governance features. Players who opt to stake their $BONE tokens unlock a range of in-game benefits such as reduced transaction fees, priority access to new fishing areas, and exclusive equipment options. In addition, staked tokens confer limited governance rights that allow players to participate in decisions affecting certain game parameters, including adjustments to fishing rates or the scheduling of community-driven events. It is important to emphasize that these governance rights are strictly confined to in-game and ecosystem-related matters and do not grant any ownership, dividend, or profit-sharing rights in the underlying project.

The game also employs adaptive economic controls to maintain long-term stability. The system continuously monitors key metrics such as fish populations, player activity, and token velocity. In response to fluctuations in these metrics, the game automatically adjusts supply-side elements like resource regeneration rates and applies dynamic pricing models for in-game goods. Advanced machine learning algorithms are integrated into this process to predict potential imbalances and to recommend preemptive adjustments. These adaptive measures are designed to ensure that the in-game economy remains balanced and engaging, even as external conditions evolve.

These mechanisms are designed exclusively to promote in-game utility and an engaging player experience. While these mechanisms support the stability and continuous development of the in-game economy, they do not provide any assurance of real-world financial returns or profit-sharing. All benefits associated with the $BONE token are intended solely to enhance gameplay and community interactions within the *Cats Fishing* ecosystem.

3 Catching the Fish

In *Cats Fishing*, the probability of a successful catch depends on a complex interplay of three fundamental categories: *Environmental Conditions, Cat Characteristics, and Fish Properties.* These parameters interact through different correlation mechanisms that determine fishing success. Environmental factors form the foundation of fishing mechanics. Each location (Whisker Woods, PawHaven, Purr Harbor, Catnip Cove, and Norway) provides unique fishing conditions. Water properties, temperature, wind conditions, weather patterns, and time of day all influence fishing success through various correlation mechanisms.

A cat's capabilities significantly impact fishing success through several key attributes: location access, experience level, fishing technique proficiency, and premium status benefits. The inventory system, including rods, rigs, tools, and consumables, provides additional layers of strategic depth through equipment-based modifiers. Fish characteristics determine both their availability and catch difficulty. These include rarity tier (Common, Rare, Trophy), preferred fishing method compatibility, movement patterns, bait preferences, and hook size requirements. Each parameter creates specific conditions that must be met for successful catches.

The fishing success mechanism is modeled as a Poisson process for theoretical analysis, transitioning to a Bernoulli process in practical implementation. The probability of k fish biting within a time interval τ is given by:

$$\Pr(X = k; \tau, \mathbb{P}, \Lambda, \mathbb{W}) = \prod_{p \in \mathbb{P}} \mathbb{I}_p(v) \times \frac{(\lambda_\Lambda \cdot \tau)^k}{k!} \exp(-\lambda_\Lambda \cdot \tau) \tag{1}$$

Where λ_Λ aggregates all influencing parameters:

$$\lambda_\Lambda = \lambda_0 + \sum_{p \in \Lambda_+} w_p \, \lambda_p + \sum_{p \in \Lambda_-} w_p \, \lambda_p \tag{2}$$

3.1 Implementation Considerations

While the theoretical model uses continuous time, the actual game implementation discretizes time into fixed intervals (typically 5-10 seconds). This transforms the Poisson process into a Bernoulli process, where each interval presents a chance for a successful catch. The probability of success in each interval is derived from the Poisson rate through:

$$p = \frac{\lambda_\Lambda \cdot \tau}{n} \tag{3}$$

This implementation provides a balanced compromise between mathematical accuracy and computational efficiency while maintaining engaging gameplay mechanics.

4 Pricing the Fish

In this section we present our dynamic pricing methodology for the fishes in the game. We begin by formally describing some properties for the fish in the game. These properties will later play a central role in the remaining supply of fish. We can consider each *fish* as a tuple F containing (at least) the following properties:

- $l \in \mathbb{N}$: The level of the fish,
- $\ell_{\min} \in \mathbb{N}$: The minimum level that a player needs to have in order to start catching this fish,
- $k \in \mathbb{N}$: The class of fish, where, in general there can be K different classes of fish in the game.

- $t \in \mathbb{R}_{\geq 0}$: Time the fish was caught,

- $\phi : \mathbb{R}_{\geq 0} \to [0, 1]$: The freshness of the fish (i.e., how long ago it was caught). Here $\phi(t)$ is a decreasing function of t such that $\phi(t) = 0 \; \forall t \geq t^*$, for some arbitrary *spoilage time* t^*

- $\rho \in [0, 1]$: The *rarity* of the fish (color, weight, attributes, etc)

For a given fish f, we will refer to these properties as f_P, where $P = \{l, \ell_{\min}, k, t, \ldots\}$ denotes the set of properties. Our design will be based on the following guiding decissions.

GD. 1 *The price of any fish depends on its attributes. Thus, in equilibrium and all else being equal, higher level, rarer, fresher fish should have a higher price.*

GD. 2 *Spoiled fish (i.e., fish having $\phi(t) = 0$) have a price of 0.*

GD. 3 *The game has shared, finite resources. In particular, this means that players compete to catch the same fish.*

As the game evolves, players will go and catch fish either to sell or to eat. Given that the game has shared resources, we need to design a *supply chain* of fishes that reacts to the amount of fish being caught. While we can't *directly* control the amount of fish being caught (as this will depend on several factors, such as the number of players in the game, etc), we can model it, and propose a *replenishing* mechanism that reacts to this demand accordingly.

4.1 Modeling demand

Consider a specific group of fish characterized by the tuple $I = (\ell, \ell_{\min}, k)$, and let $N_I(t)$ denote the number of fish of type I at time t. Furthermore, assume that at any given time t there are $N_\ell^u(t)$ users at level ℓ. This means that these users will be able to catch any fish f such that $\ell \geq f_{\ell_{\min}}$.

Players catch fish at random times, decreasing the fish population. The *catching rate,* $\mu_I(t)$ for fish of type I at time t is proportional to both the fish population and the number of players that can catch these fish, i.e.,

$$\mu_I(t) = c_I(t) \cdot N_I(t) \cdot N_\ell^u(t) \tag{4}$$

where $c_I(t) \geq 0$ is the *catchability coefficient* — an **unknown** parameter related to the scarcity of the fish since higher c_I implies a lower population of the fish.

In practice, this rate $\mu_I(t)$ can be estimated by taking a sample average on a time window Δt

$$\mu_I(t) \approx \hat{\mu}_I(t) = \frac{\text{Number of fish caught in a window } \Delta t}{\Delta t} \tag{5}$$

Which in turn implies that rate $c_I(t)$ can also be estimated as follows:

$$c_I(t) \approx \hat{c}_I(t) = \frac{\hat{\mu}_I(t)}{N_I(t) N_\ell^u(t)} \tag{6}$$

Estimating such a parameter will be useful later in our formulation.

4.2 Supply mechanism

Notice that if we assume that fishes do not regenerate at a given rate, then, eventually, the fishes of group I will go extinct. Naturally, this is something that we want to avoid — otherwise it would ruin the UX for newer players. To that end, we present a model for how fishes *regenerate* in the game. In particular, we propose that fish regenerate according to some time-dependent random process. This is to avoid predictability of the game over time.

We propose to implement a *birth process* for the replenishing of fish. Loosely speaking, this means that fish of type I will replenish at a rate of $\lambda_I(t)$; that is, on average, we propose that there are $\lambda_I(t)$ new fishes per unit of time. Specifically, here we propose setting $\lambda_I(t)$

$$\lambda_I(t) = r_I(t) \cdot N_I(t) \left(1 - \frac{N_I(t)}{N_{I,\max}(t)}\right) N_\ell^u \tag{7}$$

where $r_I(t)$ is the intrinsic growth rate of type I at time t, and $N_{I,\max}$ is the so-called *carrying capacity* of fishes of type I, i.e., the maximum number of this kind of fish that can be in the environment at any given time. The core idea here is to algorithmically adjust $r_t, N_{I,\max}$ so that there's some sort of balance between the amount of available vs caught fish at any time.

4.3 Ensuring sustainability

To maintain a sustainable fish population and a positive user experience, we must carefully choose the supply parameters so that, adaptively,

$$\frac{\mathrm{d}\mathbb{E}[N_I(t)]}{\mathrm{d}t} = \lambda_I(t) - \mu_I(t) = 0 \tag{8}$$

Notice that here we are taking the expected value since, in practice, the catching rate, and the amount of fishes left is a random process depending on the amount of players and the activity of the game. **More concretely,** our goal is to adjust r_t and $N_{I,\max}$ to maintain a stable fish population $N_I(t)$, despite fluctuations in the death rate due to player activity.

Substituting the expressions for $\lambda_I(t)$ and $\mu_I(t)$:

$$r_I(t) \cdot N_I(t) \left(1 - \frac{N_I(t)}{N_{I,\max}}\right) N_\ell^u = c_I(t) \cdot N_I(t) \cdot N_{\ell,t}^u$$

Simplify by dividing both sides by $N_I(t)$ (assuming $N_I(t) > 0$):

$$r_I(t) \left(1 - \frac{N_I(t)}{N_{I,\max}}\right) = c_I(t)$$

solving for $r_I(t)$ yields

$$r_I(t) = \frac{c_I(t)}{1 - \frac{N_I(t)}{N_{I,\max}}} \tag{9}$$

Lastly, notice that in practice, we don't know $c_I(t)$, but can estimate it adaptively using Equation (3) above, which in turn results in an estimate to be used in Equation (5).

4.4 Pricing as a function of supply

Given the dynamic supply management described above, we can simply propose a price of a given fish of class I, in terms of BONEs as

$$P_I(t) = f_I(N_I(t), \epsilon) \cdot (\text{add ons}) \tag{10}$$

where $f_I : \mathbb{N} \times \mathbb{R}_{>0} \to \mathbb{R}_{>0}$ is a predetermined pricing function for this specific class of fish, $\epsilon > 0$ is a parameter related to the price elasticity of supply and the term *add ons* > 0 corresponds to multiple add-ons that affect the price (either positively or negatively), based on its freshness, rarity, etc. There are several potential choices of f_I, e.g.,

$$\begin{aligned} \text{Exponential:} \quad & P_I(t) = ae^{-\epsilon N(t)} \\ \text{Constant Elasticity:} \quad & P_I(t) = bN(t)^{-\epsilon} \end{aligned}$$

These are illustrated in Figure 1. While the final version of $P_I(t)$ will be discussed in a further document, *a priori* we believe that the exponential might prove itself better suited for rapid changes in the game.

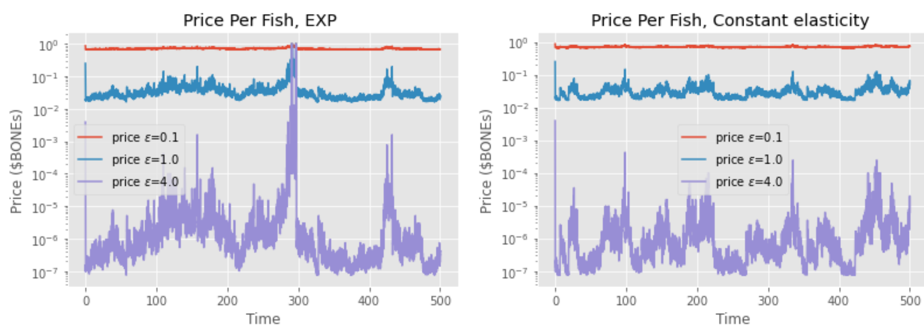

Figure 1. Price elasticity

5 Leveling up

The experience (XP) system in Cats Fishing serves as the core progression mechanism, carefully designed to maintain player engagement while supporting the game's tokenomics. In particular, level systems in games should obey an *effort-benefit analysis*; this is the case of, e.g., Role Playing Games, where higher level characters are stronger or have otherwise better developed attributes. In the specific case of *Cats Fishing*, the motivation behind leveling up is simple: **as players increase their level, they are able to use better equipment and catch increasingly rarer and more valuable fish.** In what follows, we present a comprehensive mathematical framework that governs player advancement and its implications for game design.

For a game with $K \in \mathbb{N}$ distinct fish types, each player u accumulates experience through successful catches. The total experience gained from each catch incorporates multiple strategic factors. Let $\mathsf{XP}_{\mathsf{base,i}}$ represent the base experience for fish type i, which is then modified by equipment quality, player level, and fish characteristics. Given this, the fundamental XP calculation is given by:

$$\mathsf{XP}^{u}_{\text{total},i} = \mathsf{XP}_{\text{base},i} \prod_{j \in \text{Multipliers}} \mathsf{M}^{u}_{j,i} \tag{11}$$

where $\mathsf{M}^{u}_{j,i} \in \mathbb{R}_{>0}$ corresponds to the multiplier given to a user u due to factor j when catching some fish i. These factors include, e.g., equipment bonus, level,

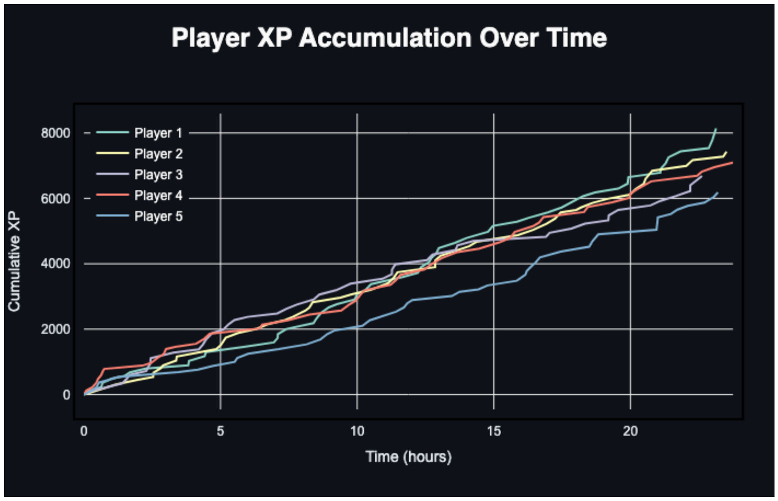

Figure 2. Example XP accumulation

how fresh the fish is, the specific type of fish caught, etc. Here, base XP values should be set proportional to fish rarity and market value:

$$\mathsf{XP}_{\text{base,i}} = \alpha \times \text{rarity}_i + \beta \times \text{market value}_i, \quad \alpha, \beta \in \mathbb{R}_{>0}, \tag{12}$$

where rarer fish can only be caught by players with a higher level (and which, all else being equal, have a higher market value).

Thus, the cumulative XP for a player who has caught $N_u \in \mathbb{N}$ fish during their whole gameplay is expressed as:

$$\mathsf{XP}^u_{\text{current}} = \sum_{i=1}^{N_u} \mathsf{XP}^u_{\text{total},i}. \tag{13}$$

This is illustrated in Figure 2.

We consider two primary approaches for level progression thresholds:

$$\text{Exponential:} \quad \mathsf{XP}^{\text{exp}}_{\text{required}}(\ell) = A \cdot B^{C \cdot \ell} \tag{14}$$

$$\text{Polynomial:} \quad \mathsf{XP}^{\text{poly}}_{\text{required}}(\ell) = \sum_{i=0}^{M} a_i \cdot \ell^i \tag{15}$$

For some constants $A, B, C, M > 0$ and $\{a_i\}_{i=0}^M$ chosen so that $\mathsf{XP}^{(\cdot)}_{\text{required}}(\ell) > 0$ $\forall l \geq 0$. Notice that one can also create a (potentially piecewise) combination of these two.

Based on game design principles and tokenomic considerations, we recommend implementing a polynomial progression system with dynamic difficulty scaling. The progression function should be:

$$\mathsf{XP}_{\mathsf{required}}(\ell) = A \times \ell^B \times D(t) \tag{16}$$

where $D(t)$ is a Dynamic Difficulty Modifier (DDM) based on server-wide progression metrics at time t. The concept of a DDM has deep roots in game design. Games like *Half-Life 2* and *Left 4 Dead* pioneered these systems through their AI Director, which continuously adjusts challenge levels based on player performance. In the MMO space, *World of Warcraft* has refined this approach over multiple expansions, implementing various catch-up mechanics that help new players join endgame content more efficiently as the game matures. For Cats Fishing, the idea is to implement a similar DDM of the form

$$D(t) = \alpha' \times \left(1 + \beta' \times \left(\frac{\ell_{avg}(t)}{\ell_{target}(t)} - 1\right)\right) \times \left(1 + \gamma \times \left(\frac{N_{active}(t)}{N_{base}} - 1\right)\right) \tag{17}$$

In this setting, when players progress faster than intended (that is, when average level exceeds target level), the XP requirements gradually increase to maintain game longevity and economic balance. The system also responds to player population changes – as the player base grows beyond baseline expectations, requirements adjust slightly to prevent economic inflation, similar to *EVE Online*'s resource spawn rate adjustments. Conversely, if average levels fall behind target or player counts drop, the requirements decrease, creating natural catch-up mechanics for new or returning players.

The implementation draws inspiration from several successful games. *Guild Wars 2*'s dynamic events system adjusts difficulty based on participant count and success rates, while *Path of Exile* regularly tunes its progression rates based on league performance data. *Final Fantasy XIV* implements experience bonuses for classes below the average level, creating natural catch-up mechanics that maintain healthy player distribution.

Remark. *The implementation parameters ($\alpha, \beta, \gamma \in \mathbb{R}$) can be fine-tuned as player data becomes available.*

References

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