



Instructor guide to the Renewable Fishery

Laboratory implementation, theoretical foundations,
experimental evidence, and variants

Behavioral and Experimental Economics Research Lab
Department of Economics



Revised edition | October 2026

<https://beer-lab.org/>

How to use this guide

This guide supports the preparation, implementation, and classroom discussion of the **Renewable Fishery** family developed by the Behavioral and Experimental Economics Research Lab (BEER Lab), Department of Economics, Tecnológico de Monterrey. It is intended for instructors in microeconomics, environmental and natural-resource economics, public economics, development, game theory, institutional economics, and experimental economics. No previous experience with oTree, population models, or common-pool-resource experiments is assumed.

The document offers three reading paths. The quick guide contains the operational choices needed to open a session. The participant-experience chapters explain the screens, calculations, and biological sequence. The conceptual chapters develop theory, evidence, and feedback scripts. Common instructions appear once; each treatment section then identifies only what changes relative to the open-access benchmark.

The activity separates three levels that classroom discussions often blur. The first is the *individual decision*: how much effort each fisher assigns in the current season. The second is the *strategic outcome*: one person's harvest depends on both individual and aggregate effort. The third is *ecological feedback*: extraction reduces the remaining biomass and changes future opportunities. A rigorous discussion should describe these facts before attributing them to selfishness, coordination, information, or intertemporal discounting.

Author

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For the instructor

This guide follows the English interface. Spanish configurations reproduce the same logic and parameters. Project only the aggregated, anonymous report. Never display participant codes or connect choices to names, student IDs, computers, or seats.

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Quick guide and learning objectives

1.1 Access through the updated laboratory website

Start at <https://beer-lab.org/en/>. Select **CLASSROOM** in the top navigation menu; it opens <https://teaching.beer-lab.org/en/>. In the **Classroom experiments** catalog, use the search box to locate the activity by name. You can also filter by **Topic** or **JEL code**. Clear any filters left from an earlier search before looking for another game.

Each family's card distinguishes **Español** and **English** access links. The **Show extended version** checkbox selects that edition before following a link. Catalog language and session language are separate choices: verify both. Students use the room specified by the instructor; the instructor prepares and monitors the session through this family's own administrative pages.



Figure 1.1: Current institutional website. Select **CLASSROOM** in the top navigation menu to open the teaching experiments. Captured on October 7, 2026.



Figure 1.2: Current catalog: search by title, topic, or JEL code. Then locate this family's card and select language and edition. Captured on October 7, 2026.

Checking resources, comprehension, and participant requirements

Before opening the room, check the selected configuration and the number of students present. The session-creation form states the group size and minimum required by that configuration. An individual activity accepts any positive participant count; an interactive activity must satisfy its stated requirement: complete groups when size is fixed, or a minimum participant count when size is flexible. Requirements may change across treatments, for example when adding a third party or changing an institution's size. If you edit a grouping parameter, check the requirement for the edited configuration, rather than relying only on the demo's suggested count.

In the instructions, ensure that students can identify what each role receives, what they can decide, and how the outcome is calculated. An initial account, a distributable budget, and final earnings need not be the same amount. Refer to the resources panel and the example for the selected treatment. Do not carry the basic edition's endowment into a treatment that changes accounts or introduces additional positions.

ECU stands for *Experimental Currency Units*: the activity's unit of account. An outcome of 100 ECU does not automatically equal 100 pesos or 100 dollars. Conversion depends on the session configuration. Before announcing a payment, confirm with the laboratory whether money is paid, the conversion rate, and which decisions count for payment. In hypothetical modules, describe amounts as outcomes in the stated situation.

When a comprehension check is included, an incorrect response receives an explanation beside that question, identifying the submitted answer and the correct answer. Other answers remain in the form. Ask the student to return to the example, locate the relevant rule, and redo the calculation before correcting the response. Avoid revealing answers to the entire class for an individual error, and do not interpret a comprehension mistake as an economic choice in the game.

novable — una temporada	Pesquería renovable / Renewable Fishery — BEER Lab Seleccione una variante de este juego. Select a version of this game.
novable — 10 temporadas, mismos pescadores	
novable — 10 temporadas, pescadores reasignados	
fishery — one season	
fishery — 10 seasons, same fishers	
fishery — 10 seasons, reassigned fishers	
novable extendida — acceso abierto	
novable extendida — comunicación estructurada	
novable extendida — mayor descuento del futuro	
novable extendida — pronóstico ecológico	
novable extendida — regeneración lenta	
novable extendida — choque ambiental	
novable extendida — precio alto del pescado	
novable extendida — bono por conservación	
Renewable Fishery — open access	
Renewable Fishery — structured communication	
Renewable Fishery — stronger discounting of the future	
Renewable Fishery — ecological forecast	
Renewable Fishery — slow regeneration	
Renewable Fishery — environmental shock	
Renewable Fishery — high fish price	
Renewable Fishery — conservation bonus	

Figure 1.3: Demo contains only the configurations of this game family, in both languages and editions.

Rooms

Current rooms:

[ES] Pesquería renovable
[EN] Renewable Fishery
[ES] Pesquería renovable: extendida
[EN] Renewable Fishery: extended

Figure 1.4: Rooms contains the four rooms for this family: basic and extended editions in Spanish and English.

Room: [EN] Renewable Fishery

Create a new session

Session Config

[EN] Renewable Fishery — one season

Number of participants

Complete groups of 4 participants. Use a multiple of 4; minimum 4.

Create

[Configure session](#) 

App sequence

renewable_fishery_game (10 rounds)

A classroom adaptation of dynamic common-pool fishery experiments.

Figure 1.5: Session-creation form for the basic English room. Check the selected configuration and participant requirement before creating the session.

Downloading a session with several rounds

For the instructor

Open **Data** within the relevant session and use that session's CSV or CSV-for-Excel download link. The general export has one row per participant and columns for the different rounds. Ten rounds do not necessarily mean ten rows per person. When the family provides its own long-format export, observations may instead be organized by participant and round or another unit defined by the design.

Save the original file together with the configuration name, session code, and active-round count. Check that columns for the last active round are present and that the data belong to the selected session. Empty cells can represent inactive rounds, a pending decision, or a field that does not apply to a role; do not automatically recode them as zeros. To compare learning, preserve round and group identifiers alongside participant identifiers. Share only anonymous aggregates in class, and record session incidents before constructing derived tables.

1.2 Family profile

Purpose	Show how a profitable current action can impose costs on other users and reduce the future productivity of a renewable resource.
Architecture	Four fishers simultaneously choose how much effort to exert on a shared fishing ground.
Unit of account	Experimental Currency Units (ECU). Each participant receives 40 ECU per season before fishing revenue and effort costs.
Decision	Integer effort from 0 to 10 units.

Ecological state	Initial stock and carrying capacity of 100 units; logistic growth after harvesting.
Basic edition	One season; ten seasons with a fixed group; ten seasons with fishers reassigned among persistent fishing grounds.
Treatments	Open access, communication, stronger discounting, ecological forecast, slow regeneration, environmental shock, high price, and conservation bonus.
Suggested duration	25–35 minutes for one season; 50–65 minutes for ten seasons; 75–90 minutes to compare two institutions.
Group size	A multiple of four. The interaction unit is a four-person fishing ground.
Instructor access	renewablefishery.beer-lab.org/demo .
Outputs	Private report with effort, harvest, profit, biomass, sustainability, and time paths.
Experimental unit	Interactions in groups of 4 participants.
Extended edition	open access; structured communication; stronger discounting of the future; ecological forecast; slow regeneration; environmental shock; high fish price; conservation bonus.
Outcome	Harvest, income, stock, and cumulative welfare over the session horizon.
Topics	renewable resources; tragedy of the commons; externalities; sustainability; fisheries.
JEL	C92; Q22; D62.

Attention

The production domain is the proposed deployment route for the laboratory. Until DNS and the production process are complete, use localhost:8046/demo to test this family. The next family, Fishery with Quotas, will introduce explicit harvesting rights. The present activity deliberately retains open access.

1.3 Learning objectives

By the end of the activity, students should be able to explain why a renewable resource is not an unlimited resource. A population may regenerate, but growth depends on the stock left after harvesting. When stock is very low, little reproductive biomass remains; when stock approaches carrying capacity, environmental pressure also slows growth. This nonlinear relationship means that the same harvest has different consequences at different resource states.

Students should also identify the contemporaneous externality. More individual effort raises that person's share of the harvest, but also raises total effort. Other people's harvests and the productivity of each effort unit therefore depend on choices that no one controls alone. The private incentive may create more pressure than is desirable for the group, even when everyone understands the biology.

A third objective is to distinguish static efficiency from dynamic sustainability. In a one-season game, there is no future inside the activity and preserved biomass does not generate later payments. In ten seasons, the stock left today determines tomorrow's opportunity set. An action can raise current ECU while reducing the value of continued fishing. The relevant comparison involves the

whole path, rather than one round's profit or terminal stock in isolation.

Finally, students should compare institutions and mechanisms. Communication changes coordination; the forecast changes information; discounting changes the weight of future earnings; slow regeneration changes ecological resilience; a high fish price strengthens the extraction incentive; an external shock changes the state without being caused by the group; and a terminal bonus assigns private value to conservation. Because these interventions operate through different margins, they should not be treated as interchangeable policies.

Theoretical foundation

The tragedy of the commons does not mean that every shared resource must collapse or that its users cannot cooperate. It is a prediction about incentives under particular institutions. Rules, communication, information, repetition, monitoring, and expectations can change the outcome. Use the game to identify mechanisms, rather than as proof that one ownership arrangement is universally superior.

1.4 Minimum classroom sequence

1. Choose version, language, and treatment. Confirm that participant count is a multiple of four.
2. Enter through beer-lab.org, open teaching.beer-lab.org, and select **Renewable Fishery**.
3. Confirm that Demo lists 22 configurations and Rooms lists only the four rooms in this family.
4. Create the session from Demo or the appropriate room. Keep Monitor and Report in separate tabs.
5. Give students only the room link. Do not announce the overexploitation hypothesis before they decide.
6. Let participants read, answer comprehension questions, and decide quietly. A wait page means that someone in the same fishing ground has not completed the stage.
7. Track progress in Monitor. Do not reveal the report while decisions are pending.
8. When the session is complete, click **Reveal aggregate results** and lead feedback from facts to mechanisms.

Checkpoint

Before opening the room, verify the connection, participant count, language, horizon, treatment, absence of active sessions, family isolation, Monitor and Report tabs, projector, late-arrival plan, and time reserved for feedback. Open each link once and do not share individual URLs.

Access, rooms, and family isolation

2.1 From the institutional portal to the game

The teaching route begins at the BEER Lab website. From beer-lab.org, instructors open the teaching catalog at teaching.beer-lab.org and select the Renewable Fishery card. The proposed deployment points to renewablefishery.beer-lab.org. The instance must start with `GAME_FAMILY=renewablefishery`, so Demo, Rooms, Sessions, and Data contain only this family.

Demo contains six basic and sixteen extended configurations: three horizons or grouping arrangements per language and eight treatments per language. That breadth belongs in the instructor view. Participants must not receive Demo or the administrator password. They enter through a room whose menu is restricted by language and version type.

For the instructor

The isolation check is part of session preparation. If Dictator, Trust, Insurance, or another family appears, the instance was not started with the proper filter. Do not create a session until the administrator corrects the environment. Isolation prevents participants from choosing a different game and prevents sessions and exports from unrelated families from being mixed.

2.2 The four rooms

The family has four stable rooms. `pesqueria_renovable_es` contains three basic Spanish versions; `renewable_fishery_en` contains three basic English versions; `pesqueria_renovable_extendida` contains eight Spanish treatments; and `renewable_fishery_extended` contains the eight English treatments. This architecture preserves predictable routes without creating one room for every treatment.

The proposed routes share <https://renewablefishery.beer-lab.org/> and use the following exact paths:

- basic ES: `/room/pesqueria_renovable_es`;
- basic EN: `/room/renewable_fishery_en`;
- extended ES: `/room/pesqueria_renovable_extendida`;
- extended EN: `/room/renewable_fishery_extended`.

For local tests, replace the domain with `localhost:8046`. A room route does not create a session

by itself. It gives the instructor a form for choosing configuration, size, and session label.

2.3 Create and distribute a session

Select a configuration and enter the total number of participants. Use a multiple of four. If 18 students attend, a 16-person session creates four complete fishing grounds and leaves two observers. A 20-person session should not be opened on the assumption that two empty positions will fill themselves. Incomplete groups cannot calculate total effort, harvest, or growth.

After session creation, oTree displays individual links and a general joining route. In an in-person class, distribute the stable room route or the session-wide join mechanism and allow the platform to assign positions. For an instructor rehearsal, open each individual link in a separate private browser context. Four tabs in one browser profile can share cookies and replace one participant with another.

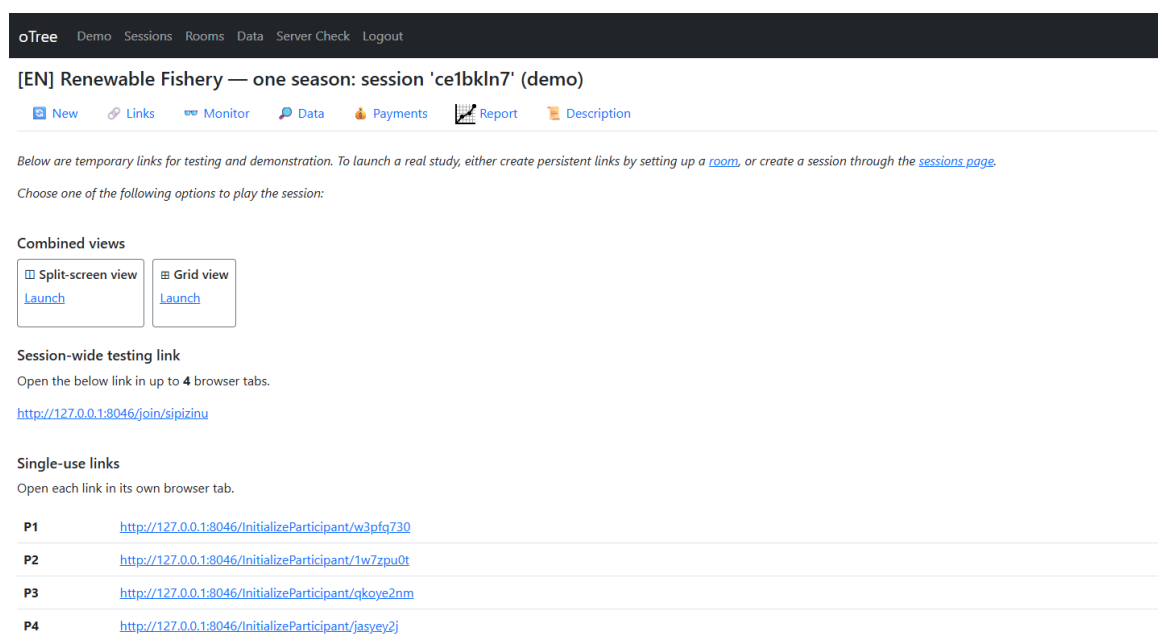


Figure 2.1: Links for a four-fisher demonstration session.

Keep three views available: Monitor to check pages, Report for the private summary, and the room route to assist anyone who closes the browser. Do not use Report as a public progress screen. It remains hidden until all expected decisions are complete, preventing partial distributions from influencing participants who have not yet chosen.

Checkpoint

Immediately before sharing the link, confirm that the session label identifies course and treatment; participant capacity is a multiple of four; configuration matches the announced language; Monitor shows the expected total; Report is open in a private instructor tab; and the distributed route belongs to the room rather than Demo or one specific participant. This one-minute check prevents the most common operational errors.

2.4 Immediate room preparation

Run a short rehearsal with the same configuration that will be used in class. The rehearsal should reach at least the first decision and its results page. Confirm that the endowment, effort limit, number of seasons, and information about regeneration match the announced treatment. In communication treatments, also verify that the discussion period appears before the decision and that students understand that agreements are not binding. Close these rehearsal sessions before participants arrive so that they cannot be mistaken for the live class session.

When the class enters the laboratory, project only the room name and its stable route. Ask each student to open the link once and keep that tab available. If someone reloads the page or loses their place, recover the participant from Monitor before adding another slot. If attendance is not a multiple of four, decide before starting whether some students will observe or whether the instructor will complete a group in private browser windows. Do not change that rule after observing the first decisions.

Record the exact configuration name, effective attendance, start time, and any incident in the instructor notes. Also document additional oral instructions, interruptions, or choices made by the instructor to complete groups. This record helps interpret unusual outcomes and repeat the activity in another course under comparable conditions. At the end, confirm that Report contains every expected participant before projecting the figures or downloading the data.

The participant experience

3.1 Welcome, laboratory rules, and instructions

The first screen presents the laboratory logo, the educational purpose, and general rules: work quietly, do not talk, do not observe other screens, and ask the laboratory team for help. Participants must accept these rules to continue. Acceptance organizes the session; it does not replace informed consent if the activity becomes research.

The instructions show the fishing ground, four fishers, effort range, stock, and sequence. Instructors should not summarize the rule as “more effort means more profit.” A participant with more effort obtains a larger share, but total harvest is constrained by stock and aggregate effort. Each effort unit also has a cost. The marginal return changes with the resource state and the choices of others.

The interface uses a stock diagram so the choice does not appear as an isolated number field. The stock is represented as a shared asset; boat and water icons keep the physical system visible. These elements serve a teaching purpose: they link each number to a system component and reduce confusion among stock, harvest, growth, and the ECubalance.

3.2 Comprehension checks

Before deciding, each person answers three questions. The first computes current ECU from a given harvest and effort. The second computes benchmark maximum growth. The third recognizes that, other things equal, more harvest today leaves less stock tomorrow. An incorrect answer produces an explanation and allows another attempt; no participant is excluded for making a mistake.

Do not dictate answers. If several students struggle, clarify the sequence aloud and have everyone recompute. In the benchmark, harvest of 10 at price 4 produces 40 ECU in revenue; effort 5 costs 20; adding the endowment of 40 gives 60 ECU. Under logistic growth, remaining stock 50 and rate 0.50 produce 12.5 units: $0.50 \times 50 \times (1 - 50/100)$.

Passing these checks does not show mastery of the complete dynamic model. It verifies the minimum components needed for an informed decision. The later discussion can show why feedback remains difficult even for people who correctly calculate each component separately.

3.3 Effort decision

In every season, participants observe initial stock, current parameters, relevant history, and an effort menu from 0 to 10. Choices are simultaneous and private. Special treatments show only the pertinent addition: forecast, shock notice, or discount factor. The interface keeps the same visual



Welcome to the BEER Lab

The **Behavioral and Experimental Economics Research Lab** of the Department of Economics at Tecnológico de Monterrey is a space designed to learn about economic decision-making through controlled activities.

In this activity we will study how current extraction changes a shared biological resource and future economic opportunities.

During the session

- Remain silent and do not talk or communicate with other participants.
- Make your decisions individually and privately. Use only the communication options provided by the game.
- Follow the on-screen instructions. Do not refresh, close, or leave this page.
- If you need help, raise your hand or contact the laboratory staff privately.

I have read and understood the laboratory rules.

- ☐ Sí
- ☐ No

Start

Powered by [oTree](#)

Figure 3.1: Opening the participant experience. Welcome and laboratory rules.



Basic version · One season



How the fishery works

You share a fishing ground with three other people. Each season everyone simultaneously chooses how much fishing effort to exert.

Resources and unit of account

Monetary endowment per participant and round: 40 ECU. The fish stock is a separate resource measured in fish units.

ECU stands for Experimental Currency Units. It is the unit of account for this activity.

This session does not convert ECU into real money.

Open access

Each person chooses effort without binding coordination.

Sequence of a season

1. Observe the biomass available at the beginning of the season.
2. Privately choose between 0 and 10 units of effort.
3. Group effort determines total catch; each individual catch is proportional to that person's effort.
4. The remaining biomass regenerates and becomes next season's stock.
5. Observe your ECU and the new biomass before continuing.

Biological dynamics

Maximum biomass is 100. Catch rises with stock and effort. At most 80% of the stock can be removed in one season. After harvesting, remaining biomass grows according to a logistic rule.

$$\text{growth} = \text{rate} \times \text{remaining biomass} \times (1 - \text{remaining biomass}/100)$$

Revenue and costs

Each season starts with 40 ECU. You receive the price for your catch and pay 4 ECU for each unit of effort. High effort may raise current catch, but it reduces biomass and future productivity.

$$\text{Current ECU} = 40 + \text{price} \times \text{individual catch} - 4 \times \text{effort}$$

Worked example

With stock 100, own effort 5, and total effort 20, your catch is **10,0** biomass units, and you earn **60,0 ECU** in the season. If 50 units remain after fishing, regeneration is **12,5** units.

ECU accumulate across active seasons. Biomass belongs to the fishing ground and carries over from one season to the next.

Continue

Con tecnología de oTree

Figure 3.2: Current basic-edition instructions, with initial resources and experimental units.



Review the marked questions. Each shows your answer and an explanation; your other answers are retained.



Renewable Fishery

Comprehension questions

Answer correctly before making decisions. You may consult the instructions again.

Resources and unit of account

ECU stands for Experimental Currency Units. It is the unit of account for this activity.

This session does not convert ECU into real money.

In the preceding example, how many ECU does the person earn in that season?

ECU

Your answer: 61. The correct answer is 60. Review all three answers. Remember to include effort cost and apply regeneration to biomass remaining after fishing.

If 50 units remain after fishing, how much does biomass grow?

biomass units

If total catch increases today, holding everything else constant, what happens to biomass available next season?



Check my answers

Con tecnología de aTree

Figure 3.3: Current comprehension check with an incorrect answer, its specific explanation, and retained responses.

hierarchy so a behavioral difference is not driven by an unnecessary redesign.



Con tecnología de [gTree](#)

Figure 3.4: Effort choice in the basic version.

Effort is both productive and extractive. Zero avoids the cost and yields no individual harvest; ten maximizes that person's relative share, but does not guarantee the highest profit. If everyone raises effort, desired harvest can reach the ecological cap of 80% of stock and aggregate costs increase. Integer choices support readable frequency distributions and histograms.

After submitting, participants wait until the other three members decide. Waiting is required because harvest depends on total effort. If a page remains for too long, Monitor identifies the missing stage without revealing the pending choice. Do not advance manually unless a technical failure has permanently disconnected someone and the course protocol provides for that intervention.

3.4 Season result and final summary

The result screen reconstructs the complete flow: initial stock, external shock if any, individual and total effort, individual and group harvest, remaining stock, growth, next stock, revenue, cost, and ECU. Separate containers keep harvest and growth from being read as the same quantity.

In ten-season versions, participants observe the path and continue with the same fishing ground or are reassigned, depending on configuration. The final summary presents cumulative earnings, final biomass, and special items such as discounting or bonus. That summary is private. It closes the individual experience, while the instructor report contains only aggregated information for collective discussion.

Reading the screen without anticipating feedback

During play, let each participant verify the calculation and continue without announcing whether an outcome is high or low. The result screen answers three immediate questions: what the person chose, what the group did, and how the resource responded. It does not yet establish whether the trajectory was efficient or which institution is preferable.

Con tecnología de [oTree](#)

Figure 3.5: Individual result and trajectory. Result of one season.



Activity completed

The activity has ended. Wait for the instructor's directions and do not close this page.

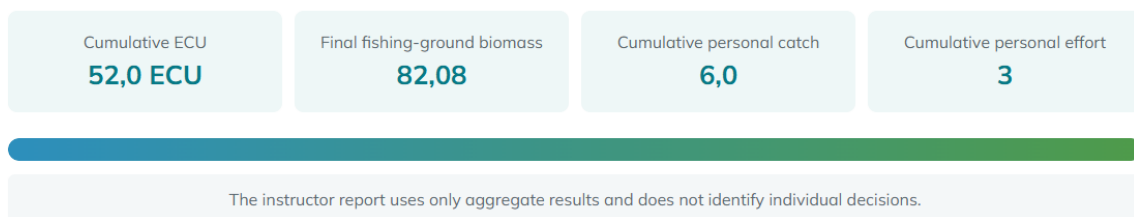
Con tecnología de [oTree](#)

Figure 3.6: Participant's final summary.

If someone asks why harvest changed despite repeating the same effort, direct attention to initial stock and total effort on the screen. This clarification explains the rule without recommending the next choice. If the participant asks what should be selected, remind the room that the task is to make an individual decision under the stated rules.

At the final summary, ask participants to notice the distinction between cumulative earnings and biomass. The two measures can move together during part of the session and later diverge. Preserving that tension until collective feedback is useful: students arrive with a private experience, while the class interprets anonymous aggregate patterns.

The bioeconomic model and worked examples

4.1 From effort to harvest

Let S_t denote stock at the beginning of season t , $e_{it} \in \{0, 1, \dots, 10\}$ fisher i 's effort, and $E_t = \sum_i e_{it}$ total effort. Desired group harvest is

$$H_t^d = 0.02S_tE_t.$$

To prevent a single season from mechanically removing the full resource, effective harvest is capped at 80% of available stock:

$$H_t = \min\{H_t^d, 0.8S_t\}.$$

When $E_t > 0$, individual harvest is proportional to effort:

$$h_{it} = H_t \frac{e_{it}}{E_t}.$$

If no one fishes, all harvests equal zero. The rule combines rivalry over common production with a private effort advantage. The coefficient 0.02 and the cap are teaching parameters chosen to produce visible paths over ten seasons, not a calibration to a particular species.

Suppose $S_t = 100$ and efforts are 2, 4, 6, and 8. Total effort is 20; desired harvest is 40, below the cap of 80. Harvest shares are 4, 8, 12, and 16. With price 4 and unit effort cost 4, the fisher choosing 2 earns $40 + 4(4) - 4(2) = 48$ ECU. The fisher choosing 8 earns $40 + 4(16) - 4(8) = 72$. This calculation shows the private attraction of raising effort when others' choices are fixed.

Now suppose everyone chooses 10. Desired harvest equals 80, exactly the cap. Each receives 20 and earns $40 + 4(20) - 4(10) = 80$ ECU. The current result appears attractive, but only 20 stock units remain before regeneration. The dynamic consequence appears in the next stage.

4.2 Logistic growth

After fishing, $R_t = S_t - H_t$ remains, unless an exogenous shock first reduced available stock. Natural growth is

$$G_t = rR_t \left(1 - \frac{R_t}{K}\right),$$

where $K = 100$ is carrying capacity and $r = 0.50$ in the benchmark. Next stock is $S_{t+1} = \min\{K, R_t + G_t\}$. Growth is zero at stock zero and at carrying capacity, and reaches its maximum

near $K/2$. With $R_t = 50$, growth is 12.5. With $R_t = 20$, it is 8; next stock after the maximum-effort example is only 28.

The logistic form corrects two misleading intuitions. Leaving more fish does not always create more absolute growth: near carrying capacity environmental pressure slows expansion. Taking stock to a very low level does not allow proportionally fast recovery either: little reproductive biomass remains, so the growth flow is small. The relationship among conservation, yield, and time cannot be summarized as “always fish less” or “nature replaces what is taken.”

Theoretical foundation

The model adapts the Gordon–Schaefer tradition for classroom use. Schaefer formalizes the link among effort, stock, and harvest; Gordon shows how common access dissipates rent; Clark explains how prices, growth, and discounting can make overexploitation economically attractive. The application preserves these mechanisms with transparent parameters and an accessible interface.

4.3 Current, cumulative, and discounted earnings

With fish price p and unit effort cost $c = 4$, current ECU are

$$\pi_{it} = 40 + ph_{it} - ce_{it}.$$

The endowment of 40 prevents negative balances under normal parameters and acts as an accounting base. It is neither fish nor a quota. Revenue depends on harvest; cost depends on effort. The report separates these components so high earnings are not automatically interpreted as ecological productivity.

In the stronger-discounting treatment, credited value is $\delta^{t-1}\pi_{it}$ with $\delta = 0.75$. The rule does not change biology or current ECU; it changes how strongly distant outcomes enter total credited earnings. The factor is one in season 1, 0.75 in season 2, and 0.5625 in season 3. Making it explicit allows students to discuss impatience without hiding it in a continuous rate.

In the conservation-bonus treatment, each participant receives $0.20S_{T+1}$ additional ECU at the end. The bonus is identical for all four members and assigns private value to terminal biomass. It does not directly reward growth in every season and does not make anyone an exclusive owner. It tests whether a relatively small terminal value can change a sequence of current incentives.

4.4 Benchmarks for efficiency

The game does not impose a single “correct effort.” Instructors can construct three benchmarks. The short-run individual benchmark asks which effort raises current ECU while other decisions are fixed. The group benchmark compares total current ECU across profiles. The dynamic benchmark compares the value of whole paths, including how stock changes future harvest. These benchmarks may rank profiles differently.

In class, calculate three symmetric scenarios at the observed initial stock: effort 2, 5, and 10 per person. Ask groups to project harvest, effort cost, next stock, and total profit. Repeat using the final stock. The same action has different consequences because the system is state dependent. This contrast is usually more useful than presenting a closed-form optimum detached from the session.

With stock 100, the three profiles yield a transparent comparison:

e_i	E	H	Next stock	ECU per person	Group ECU
2	8	16	90.72	48	192
5	20	40	72.00	60	240
10	40	80	28.00	80	320

The table does not identify a dynamic optimum. It shows that the highest-effort profile produces more current ECU in the first season while leaving much less stock. A ten-season comparison must value the harvest that remaining stock can produce, future costs, and the discount criterion. Showing this table before the trajectory helps students state the tension numerically rather than only in environmental language.

Sensitivity exercise

Use the same table and change one parameter at a time. At price 6, recompute current ECU without changing harvest or growth. Under slow regeneration, preserve current ECU and recompute only next stock. Under discounting, leave both physical outcomes unchanged and alter their weight in credited earnings. This procedure makes clear which equation each treatment changes.

Then assign three teams different objectives. The first considers current earnings only, the second the undiscounted sum over ten seasons, and the third an additional environmental value for biomass. Differences among their recommendations need not be arithmetic mistakes; they follow from the objective. The exercise prepares normative discussion and prevents the class from invoking efficiency without stating whose outcomes matter and over which horizon.

Finally, compare the calculation with observed behavior. If choices differ from the benchmark, list explanations before selecting one: beliefs about others, social preferences, calculation error, a heuristic, uncertainty, or experimentation. One session rarely distinguishes all of them, but the model indicates which additional measure would help.

Predictions, evidence, and mechanisms

5.1 Open access and resource rent

Under open access, each user considers the private return to effort but shares part of the cost that stock reduction imposes on the group and the future. The qualitative prediction is excessive effort relative to a coordinated choice that internalizes all effects. As effort and capacity enter, resource rent can dissipate: gross revenue rises by less than total cost, while lower stock reduces productivity.

This logic does not require bad intentions. A participant may want conservation yet fear that unilateral restraint will concede harvest to others without protecting the stock. Expectations about reciprocity and compliance are part of the problem. The activity supports asking what participants expected others to do, although beliefs are not formally elicited in this version.

The one-season version provides a reference close to the static incentive. Repeated versions add future value, learning, and history. Falling effort can reflect ecological learning, tacit coordination, response to lower stock, or cost adaptation. Rising effort can reflect competition over a shrinking resource, demand for immediate revenue, or pessimism about others. The report distinguishes descriptions; one session alone does not identify the cause.

5.2 Dynamics, discounting, and overexploitation

Clark's analysis shows that managing a living resource depends on growth, price, cost, and discounting. A weakly valued future makes conservation less attractive; a high price strengthens the immediate return to extraction; slow regeneration reduces the reward to waiting. The extended versions vary these mechanisms separately so students can compare clean environmental changes.

Interpret discounting carefully. It need not describe a participant's psychological impatience. It can stand for insecure future access, fear that someone else will harvest first, financial pressure, or a social discount rate. Asking students to identify these interpretations enriches the exercise and avoids turning δ into a moral label.

A high fish price does not prove that markets inevitably cause collapse. Price is one signal within an institutional environment. Secure rights, limits, taxes, monitoring, or agreements can change the response. That is why Fishery with Quotas is a separate family: it permits a focused comparison with explicit rights without overloading this first activity.

5.3 Information and bioeconomic perceptions

Moxnes shows that overexploitation can result from mistaken perceptions of stock, growth, and harvest in addition to strategic incentives. Someone may understand that fishing removes fish yet still assume regeneration is proportional or faster than it is. The ecological-forecast treatment addresses this channel by displaying scenarios before effort is chosen.

If the forecast reduces effort and protects stock, the result is consistent with helpful information. It does not show that the entire problem was cognitive: the table may also make interdependence salient or act as an implicit recommendation. If behavior does not change, information may still be understood while private appropriation incentives dominate. Present these competing interpretations in the debriefing.

5.4 Communication, cooperation, and institutions

The common-pool-resource literature associated with Elinor Ostrom and a large body of laboratory and field work shows that communication can support coordination, commitment, and shared norms. Here each fisher simultaneously recommends an effort level. Recommendations appear before the binding choice and cannot be enforced. There is no free-form chat, punishment, or named reputation.

This structure protects instructional control and prevents inappropriate messages, but limits inference. A number can coordinate a focal point; it cannot express conditional promises or design a complex rule. A gap between recommendations and actions can reflect temptation, uncertainty, or strategic messaging. Compare mean recommendation, mean effort, and dispersion without identifying participants.

Feedback script

Ask in this order: What happened to stock? What happened to total effort? How did harvest per unit of effort change? Do current and cumulative earnings tell the same story? Which mechanism can connect these variables? Only then compare with open access or another treatment. This sequence keeps description, explanation, and normative evaluation separate.

Instructor report and interpretation

6.1 Controlled release

The instructor report is private and remains hidden while decisions are incomplete. The page states how many observations are expected and how many are complete. This barrier prevents partial distributions from being projected and influencing remaining participants. When the session finishes, the **Reveal aggregate results** button appears. Revealing changes only the instructor's browser view and does not alter data.

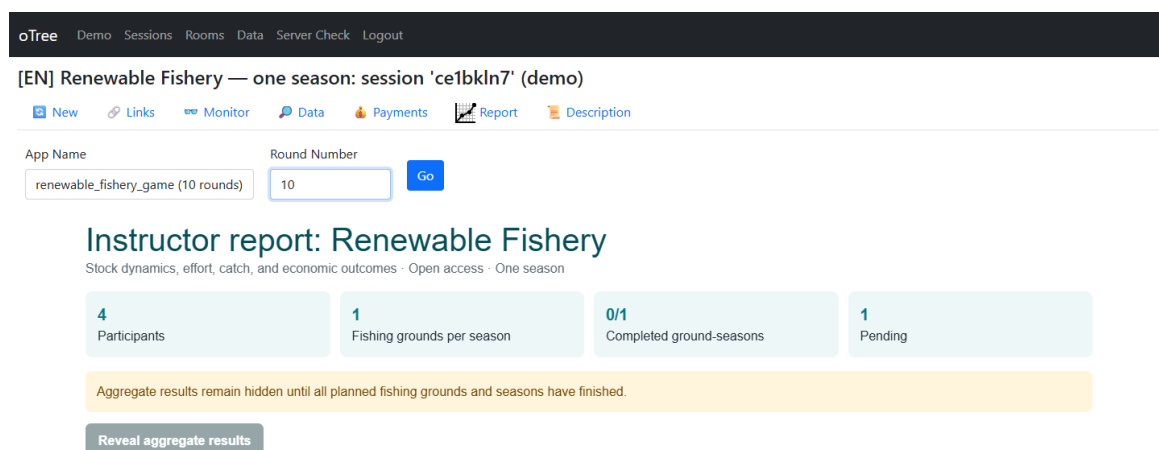


Figure 6.1: Controlled release of classroom results. Protected report during the session.

The header summarizes participants, fishing grounds, seasons, mean effort, final biomass, harvest, earnings, and the share of sustainable grounds. Histograms of effort and final biomass, time-path charts, and round tables follow. Colors have consistent functions: blue for decisions or main series, green for conservation, and orange or red for pressure and alerts. Labels appear inside proper containers rather than as isolated blue text.

6.2 Core indicators

Mean effort describes average intensity but can conceal dispersion. A mean of five can come from four choices of five or a mixture of zero and ten, so pair it with the histogram. **Total effort** links directly to desired harvest and allows comparisons across fishing grounds.

Final biomass summarizes the terminal state. It does not measure efficiency on its own: a group may preserve everything and forgo valuable harvest, or harvest at a level compatible with regeneration. Compare biomass with cumulative harvest and ECU. The **sustainability rate**

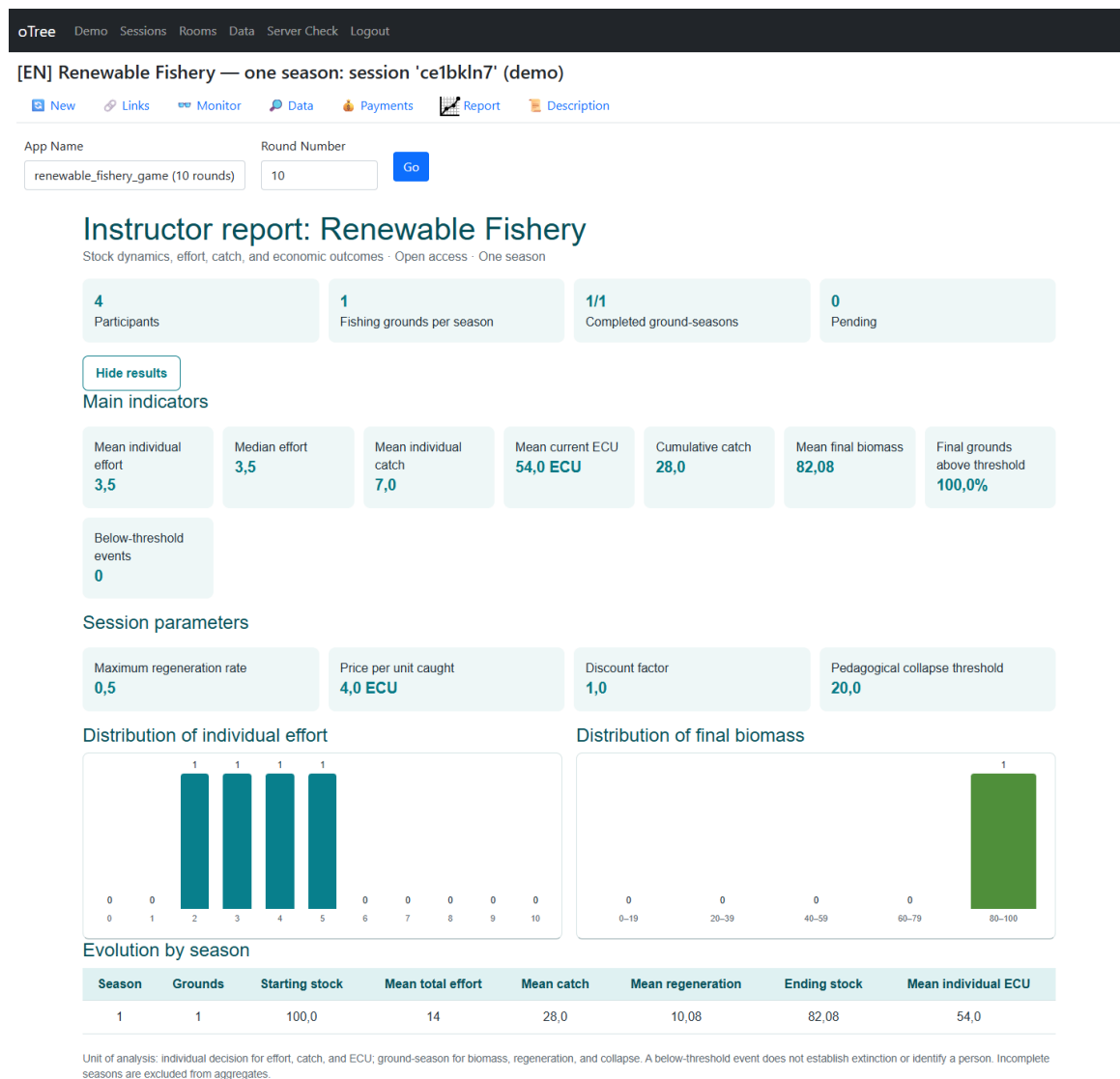


Figure 6.2: Aggregate report after release.

classifies grounds using the transparent threshold in the report; treat it as a descriptive signal, not a universal biological boundary.

Harvest per unit effort approximates productivity. When it falls, a group may be spending more effort for each unit obtained. This measure connects ecology to economic rent and helps explain why more vessels or hours need not produce higher net returns.

Current, credited, and cumulative earnings must remain separate. Their difference is mechanically central under discounting, while the terminal bonus appears separately. Levels across configurations reflect different parameters and should not be compared without stating treatment and horizon.

6.3 Histograms and time paths

Histograms preserve the distribution erased by a mean. Ask whether choices display consensus, polarization, or tails. Under communication, compare recommendations and actions. With a high price, examine whether the entire distribution shifts or only the frequency of maximum effort rises. With a shock, separate seasons before and after season 5.

The time chart places effort, stock, and harvest in sequence. Avoid interpreting a contemporaneous correlation without lags: effort in t affects stock in $t + 1$, while harvest in t depends on stock at the beginning of t . Marking this timing prevents attributing to a choice a state that already existed when the choice was made.

6.4 A five-step reading protocol

First establish context: treatment, number of grounds, and seasons. Second inspect the choice: level and dispersion of effort. Third follow the physical mechanism: harvest, remainder, growth, and next stock. Fourth connect to economic outcomes: revenue, cost, productivity, and ECU. Fifth compare against a benchmark or treatment and state what additional evidence would be needed for a causal claim.

Do not open by asking who behaved selfishly. That wording personalizes a problem involving incentives, expectations, and dynamics. Ask about choices and states. Anonymity protects students and also improves the conceptual quality of feedback.

6.5 Diagnostic questions

Before attributing a pattern to cooperation, make four checks. Did effort respond when stock changed? Did productivity fall while effort remained stable? Did fishing grounds follow similar or divergent paths? Does the distribution show consensus or a mixture of extremes? Each question addresses a different part of the mechanism.

Under communication, add the gap between recommendations and choices. Under forecasting, inspect whether decisions respond to scenarios with different next stocks. Under discounting, separate current and credited ECU. Around the shock, use season 4 as the immediate benchmark and inspect seasons 5 and 6. Under high price, compare gross revenue and net profit. Under the bonus, ask when adjustment begins rather than looking only at terminal biomass.

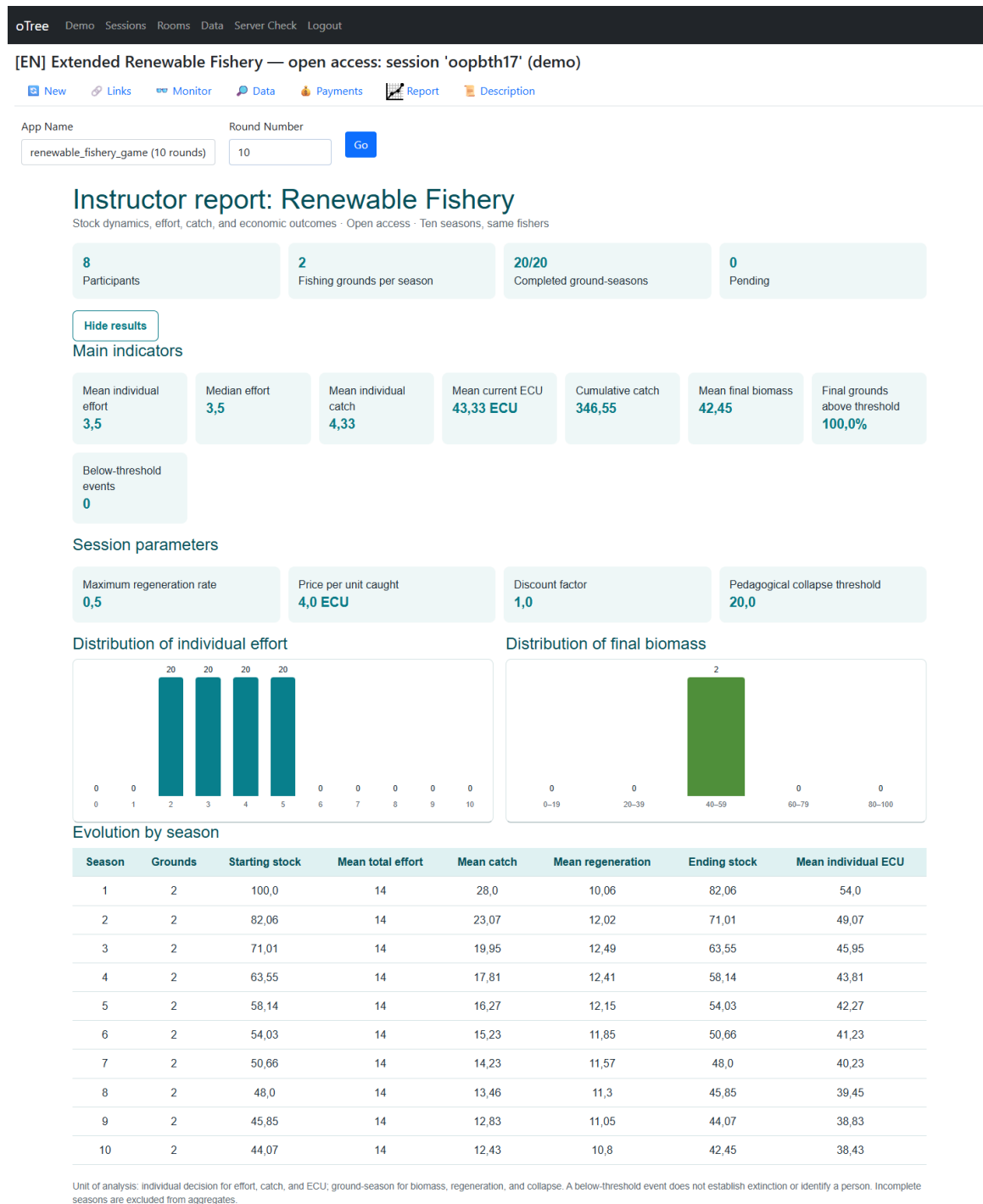


Figure 6.3: Extended open-access report with distributions and time paths.

For the instructor

When the report cannot answer a question, present that gap as a measurement need. Do not fill it with an unsupported psychological story. The debrief should teach the link between evidence and mechanism, including explicit recognition of what the session cannot identify.

Basic versions

7.1 One season

This configuration isolates the static problem. It suits a short introduction to externalities, production functions, or simultaneous games. Because there is no later season, final biomass generates neither future harvest nor a bonus. Use it as a baseline before announcing that the resource will persist.

Do not state that everyone should choose ten. Effort cost, proportional allocation, expectations, and social preferences can produce different choices. The teaching value is the tension: a participant may capture a larger share by increasing effort, while the group bears additional cost and leaves less biomass. After results, calculate symmetric profiles and ask what changes when stock has future value.

7.2 Ten seasons with a fixed group

The same four fishers remain together and their stock evolves. Repetition allows learning, tacit coordination, and path dependence. Heavy early extraction shrinks later opportunities; a moderate path can sustain productivity. Anonymous group continuity remains even though names are never shown.

Use this version to connect social dilemma and dynamics. Do not promise beforehand that cooperation raises payoffs. In feedback, compare early and late seasons, identify turning points, and ask whether the group responded to stock or merely repeated a rule.

7.3 Ten seasons with reassignment

Fishing grounds retain their position and ecological history while participants move among them. The resource does not reset when partners change. A fisher can enter a ground degraded by earlier users or benefit from conserved stock. Mobility reduces social continuity and creates an externality across cohorts.

This version supports discussion of transient users, mobile labor, short concessions, or fleet rotation. It is not random matching with a new resource every round. Compare dispersion among grounds, responses to inherited stock, and differences from fixed groups. Avoid a causal claim if sessions used different classes or sizes.

Extended treatments

8.1 Open access

The extended open-access treatment uses ten seasons, fixed groups, and benchmark parameters: initial stock 100, growth rate 0.50, price 4, effort cost 4, and no messages, forecasts, shocks, or bonus. It is the shared reference for all other treatments. Its organizational advantage over the repeated basic version is that it sits in the extended menu for direct institutional comparisons.



Season 1 of 10 · Open access

Choose your fishing effort

Effort increases your share of the catch, but it is costly and reduces the stock that can regenerate.

Starting biomass

100,0

biomass units

Relatively high stock

Your effort

0 means no fishing this season; 10 is the maximum effort.

Confirm my effort

Con tecnología de [oTree](#)

Figure 8.1: Initial decision in extended open access.

Document the number of grounds, initial effort, and initial stock before comparing treatments. Then assess convergence and trajectories. A general stock decline can coexist with important differences in speed, productivity, and earnings. Treat this classroom result as the empirical reference for the class rather than a universal parameter.

8.2 Structured communication

Before every effort choice, each person recommends an effort from 0 to 10. All four recommendations appear simultaneously; participants then decide privately. Messages are nonbinding, anonymous,

and restricted to a number. The design reduces risks from free-form communication while preserving a coordination channel.



Figure 8.2: Two stages of structured communication. Nonbinding recommendation.

Compare mean recommendation, dispersion, and actual effort. Agreement may indicate coordination; effort above recommendations may reflect deviation or pessimistic expectations; lower effort can indicate caution. Ask whether the message changed expectations, norms, or salience. Experimental work often finds that communication improves cooperation, but effectiveness depends on repetition, credibility, and opportunities to respond.

8.3 Stronger discounting

This treatment displays current ECU and applies $\delta = 0.75$ to credited outcomes in later seasons. Biology, price, and cost remain unchanged. Season 1 has factor one, while season 2 has factor 0.75. The difference is explicit so participants see why equal current earnings have different intertemporal weight.

The hypothesis is stronger early pressure when preserved stock produces distant credited returns. A group may still moderate effort through norms or current productivity. Discuss impatience, insecure tenure, political risk, and liquidity as possible economic interpretations. The assigned factor is not a diagnosis of participants' personal preferences.

8.4 Ecological forecast

The effort screen includes a scenario table translating aggregate effort into harvest and next stock under current parameters. It neither orders a choice nor predicts the other participants. It reduces the cognitive burden of mentally simulating feedback.

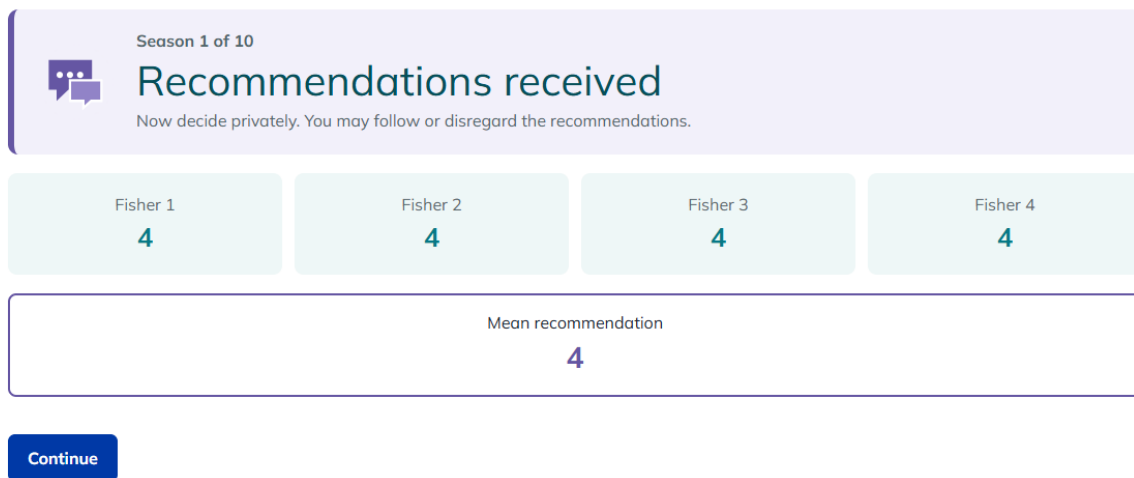
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Figure 8.3: Group recommendations before effort.

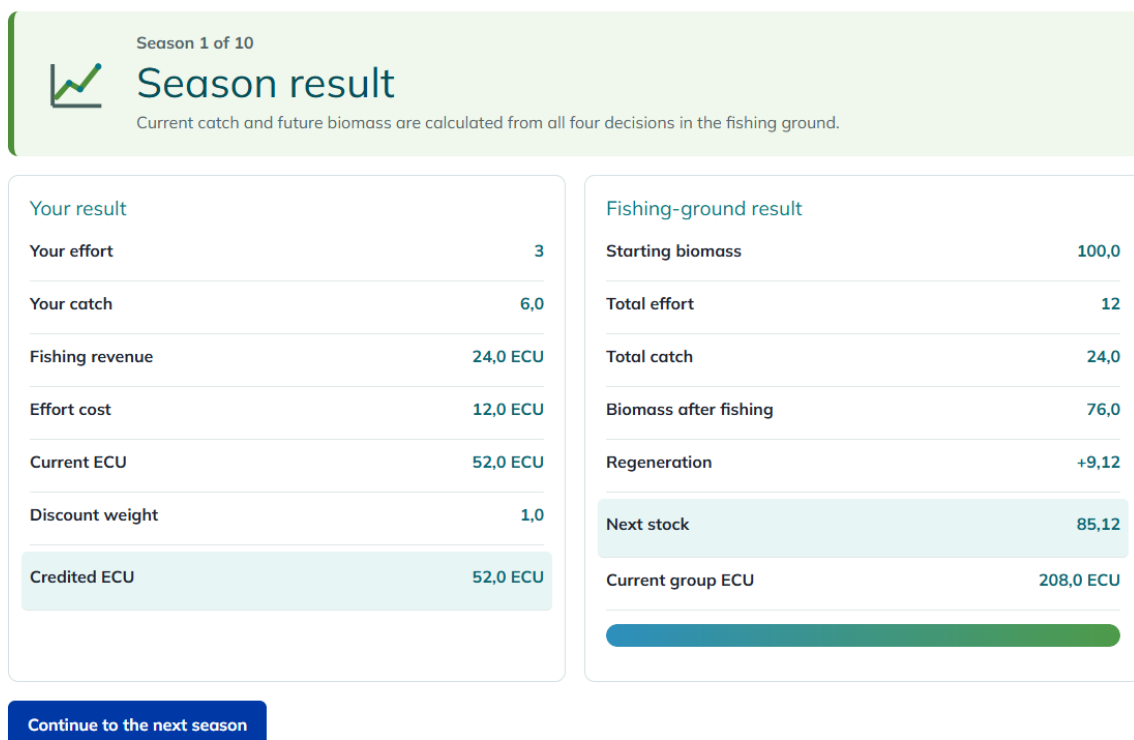
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Figure 8.4: Transparent discounting of future outcomes. Initial season, factor one.



Season 2 of 10

Season result

Current catch and future biomass are calculated from all four decisions in the fishing ground.

Your result

Your effort	4
Your catch	6,81
Fishing revenue	27,24 ECU
Effort cost	16,0 ECU
Current ECU	51,24 ECU
Discount weight	0,75
Credited ECU	38,43 ECU

Fishing-ground result

Starting biomass	85,12
Total effort	16
Total catch	27,24
Biomass after fishing	57,88
Regeneration	+12,19
Next stock	70,07
Current group ECU	204,96 ECU

[Continue to the next season](#)

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Figure 8.5: Season 2, factor 0.75.



Season 1 of 10 · Ecological forecast

Choose your fishing effort

Effort increases your share of the catch, but it is costly and reduces the stock that can regenerate.

Starting biomass

100,0

biomass units



Relatively high stock

Your effort

0 means no fishing this season; 10 is the maximum effort.

Forecast for the current stock

These scenarios assume group effort takes the stated value. They do not predict what other people will choose.

Total effort	Total catch	Regeneration	Next stock	Current group ECU
0	0,0	0,0	100,0	160,0
10	20,0	8,0	88,0	200,0
20	40,0	12,0	72,0	240,0
30	60,0	12,0	52,0	280,0
40	80,0	8,0	28,0	320,0

Confirm my effort

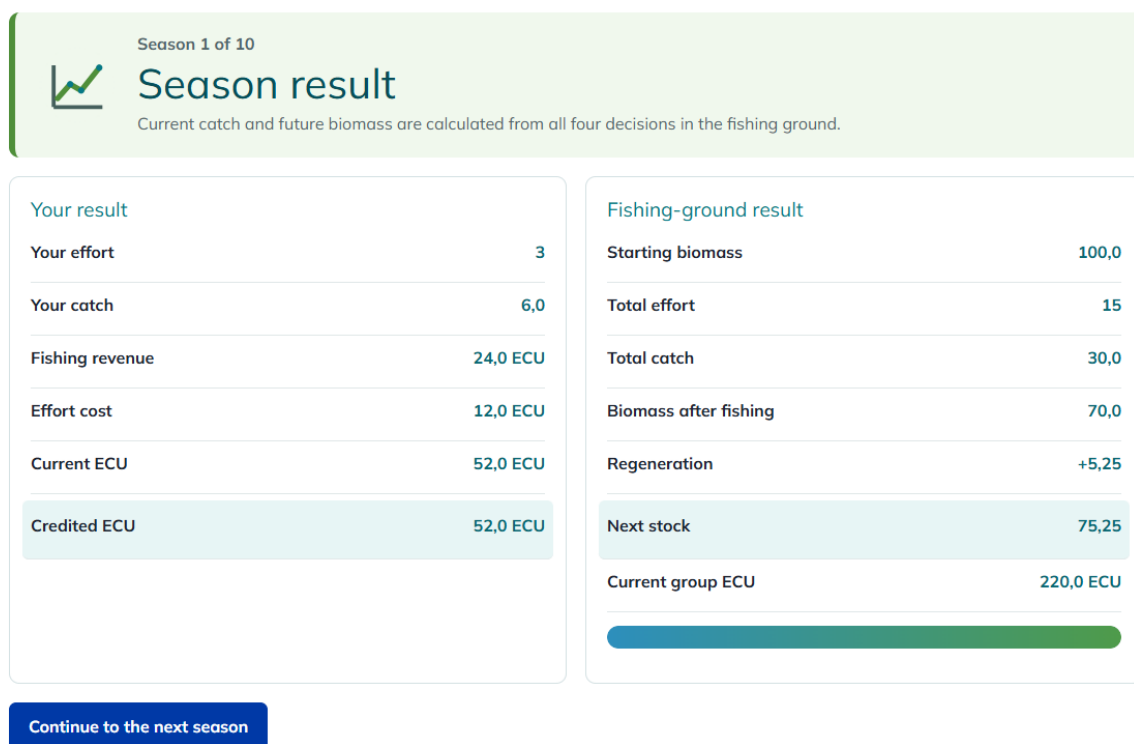
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Figure 8.6: Ecological forecast integrated into the effort decision.

Compare effort level and variation, biomass, and productivity with open access. Better conservation is compatible with useful information, but salience and implicit advice may also matter. No change does not imply that information was ignored; participants may understand it while private incentives dominate. Ask students what alternative forecast or additional data they would want.

8.5 Slow regeneration

The growth rate falls from 0.50 to 0.25; all other benchmark parameters stay fixed. With remaining stock 50, growth is 6.25 instead of 12.5. The resource absorbs less extraction and recovers more slowly. The main question is whether users adapt effort to lower resilience.



Con tecnología de oTree

Figure 8.7: Season result with slow regeneration.

Do not compare final biomass alone, because the same behavior creates a worse trajectory when r changes. Compare effort as well: adaptation means decisions respond to biology. Unchanged effort illustrates how a stable rule becomes unsustainable when an ecosystem changes. Connect the case to climate change or habitat degradation while noting that the parameter is not a specific species estimate.

8.6 Environmental shock

At the beginning of season 5, before harvesting, an external disturbance removes 30% of stock. The notice distinguishes this loss from the effect of effort. The shock does not punish a particular

choice; every member faces the new state.



Season 5 of 10 · Environmental shock

Choose your fishing effort

Effort increases your share of the catch, but it is costly and reduces the stock that can regenerate.

Environmental shock observed

Before decisions, the stock fell for an external reason.

Previous stock: **57,61** External loss: **-17,28**

Starting biomass

40,33

biomass units

Relatively high stock

Your effort

▼

0 means no fishing this season; 10 is the maximum effort.

Confirm my effort

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Figure 8.8: Environmental shock and group response. Shock notice upon entering season 5.

Compare seasons 4, 5, and 6: inherited state, effort, and recovery. The question is not whether stock falls, because that decline is programmed, but whether the group adapts. Lower effort may protect recovery; higher effort may reflect a race for a newly uncertain resource. Discuss ecological and social resilience separately.

8.7 High fish price

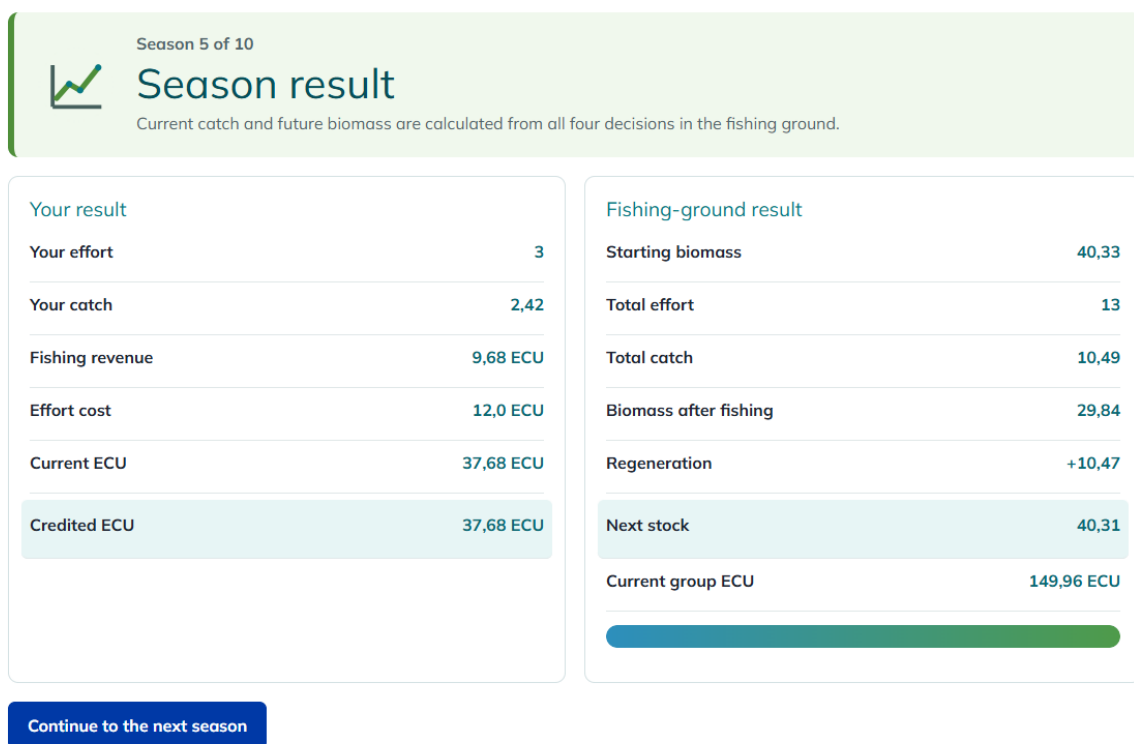
Price rises from 4 to 6 ECUp_{er} harvested unit. Effort cost and biology do not change. The treatment asks how higher gross profitability changes pressure, rent, and stock. The response need not be monotonic if depletion reduces harvest.

Compare revenue, cost, profit, and harvest per effort. A high price can raise early earnings while accelerating productivity loss. It can also make effort profitable that was not profitable before. Relate the treatment to international demand or technology while noting that real markets include regulation, elasticities, and heterogeneous costs not modeled here.

8.8 Conservation bonus

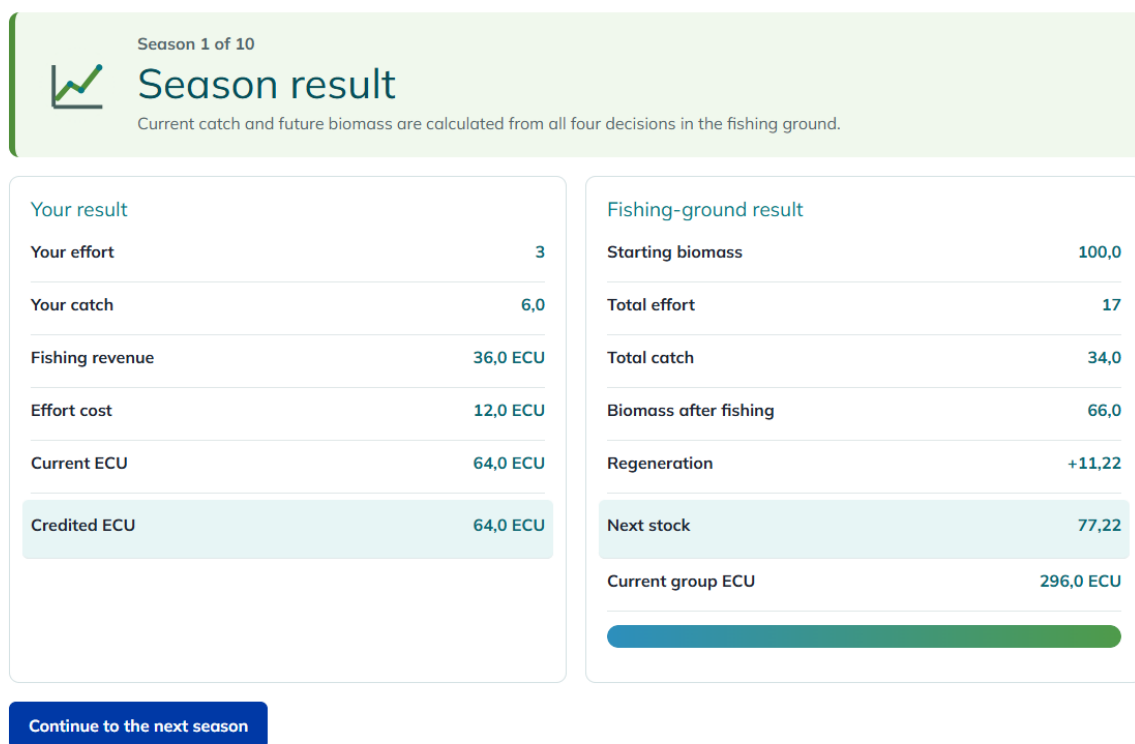
At the end of season 10, every member receives 0.20 ECUp_{er} unit of terminal stock. The bonus creates a shared conservation value in addition to current payments. Its maximum is 20 ECUp_{er} participant if final stock equals 100.

Compare early and terminal behavior, discounting, reciprocity beliefs, bonus cost, biomass, and earnings. Welfare omits biodiversity, employment, and consumption.



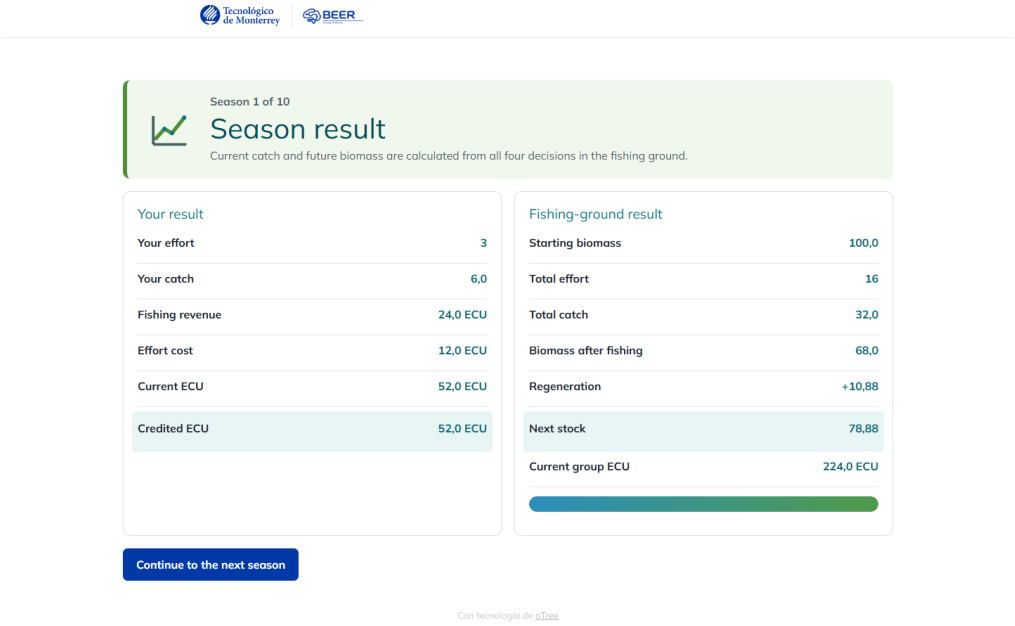
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Figure 8.9: Outcome after the disturbance.

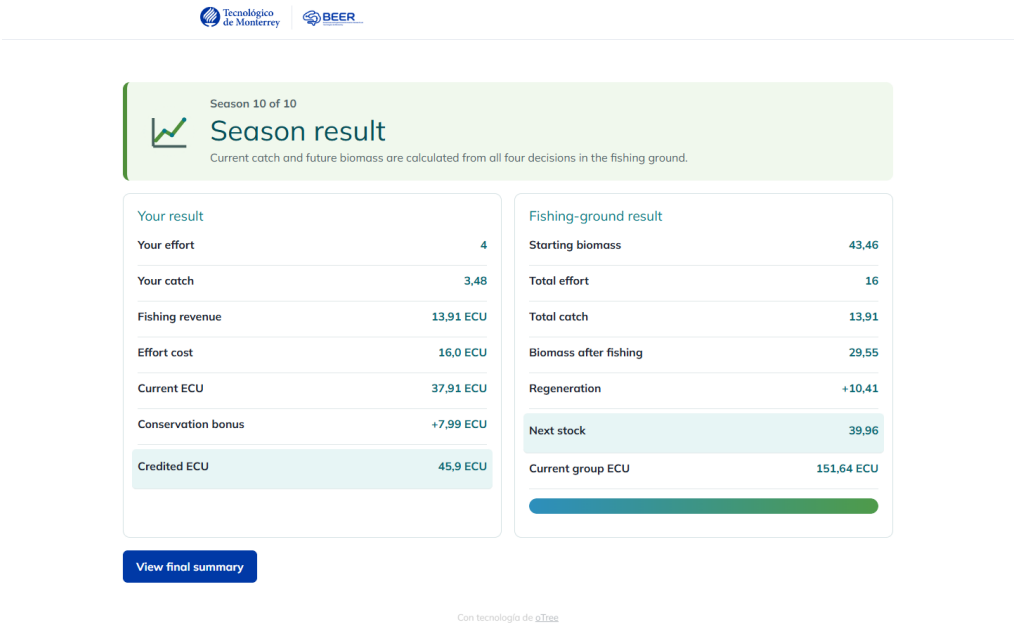


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Figure 8.10: Season result with a high fish price.



(a) The terminal bonus is announced from the start.



(b) Bonus calculation at the end.

Figure 8.11: Terminal conservation incentive.

Step-by-step implementation

9.1 Before class

Define one primary question. For an introduction, compare one season with a fixed group. For institutions, compare open access and communication. For resource economics, compare normal and slow growth. For intertemporal choice, compare open access and stronger discounting. Avoid more than two treatments in one meeting unless assistants and ninety minutes are available.

Prepare a sheet listing configuration, participant count, opening time, and route. Test the room in a private browser and confirm language. Check Welcome, Comprehension, Effort, Wait, Results, Final Summary, and Report, with no Debug info. Close rehearsal sessions to keep Monitor clear. Use the intended local or production database; never run `resetdb` in production as an improvised fix.

Decide how comparisons will be formed. Four participants in one fishing ground do not provide four independent treatment observations because their choices share a stock and history. Research use requires multiple grounds, assignment, and group-level analysis. Classroom use can discuss patterns without presenting spurious statistical significance.

9.2 While giving instructions

Request silence before distributing the route. Explain that ECUcompare outcomes in the activity and that no choice is a morally correct answer. Do not say “cooperate” or “avoid depletion” before play. Clarify only the mechanics, and answer questions publicly so everyone receives the same information.

Watch comprehension in Monitor. If one student falls behind, approach without reading the choice. If a group is waiting, identify the unsubmitted page. Do not reveal partial recommendations or effort. Under reassignment, remind participants that a fishing ground preserves its history when members change; this is a rule clarification rather than behavioral advice.

9.3 During feedback

Project Report only after release. Begin with thirty seconds of silent observation. Ask for one verifiable pattern. Draw three columns on the board: choice, dynamics, and economic result. Place each comment in a column. When someone proposes an explanation, ask what evidence supports it and what alternative explanation also fits.

Reconstruct one season numerically using a representative or rounded ground. Calculate total

effort, harvest, remainder, growth, next stock, and ECU. Then return to the trajectory. Alternating between calculation and graph keeps the discussion from remaining at the level of impressions.

9.4 Closing the activity

Use a short exit prompt: each student names one externality, one institution that could change it, and one indicator for evaluating that institution. If Fishery with Quotas will follow, do not fully solve it now. Use proposals to motivate rights, monitoring, enforcement, and distribution. Export data only when useful, and label files with date, course, treatment, and session.

9.5 Post-session record

Set aside five minutes to record what the database does not contain: actual attendance, interruptions, common questions, computers that changed user, any manual instructor intervention, and the exact moment results were released. Note whether this treatment came before or after another activity, because order can change learning and expectations.

Write down one teaching observation and one specific revision for the next class. This record separates a recurring design problem from a one-time incident and discourages changing rules after a single experience. If an explanation caused confusion, revise the text and comprehension item first. Do not simultaneously change parameters, interface, and guide, because the source of improvement would become impossible to identify.

Feedback scripts and class plans

10.1 A fifteen-minute debrief

Minutes 0–3: describe effort, dispersion, and stock without theory. Minutes 3–6: reconstruct harvest and proportional allocation. Minutes 6–9: show remainder, growth, and next stock. Minutes 9–12: connect the path to externality, rent, and discounting. Minutes 12–15: compare one institution and ask for a prediction about another treatment.

Feedback script

“Average effort was X and stock moved from 100 to Y. Before explaining why, let us reconstruct the sequence. Which variable did each participant choose? Which result depended on the group? Which part was produced by nature? What did a person gain by raising effort, and what cost remained outside that private calculation? Now let us compare the alternative treatment.”

10.2 A fifty-minute class

Allocate five minutes to motivation, eight to instructions and comprehension, fifteen to a ten-season session, fifteen to feedback, and seven to synthesis. This format works for students who already know externalities. In an introductory course, use one season and spend more time distinguishing stocks from flows.

An effective opening asks for an anonymous forecast: high, medium, or low final stock. Do not reveal the instructor’s answer. After play, compare forecasts and outcomes. The gap makes expectations visible and explains why a theory provides a benchmark rather than a perfect description of every person.

10.3 A ninety-minute comparison

Run open access for ten seasons, discuss facts for five minutes, and then assign communication or forecast in a new session. Keep parameters and group count stable. Reserve at least twenty-five minutes at the end. Ask what changed in the environment, what did not, and why the altered margin could affect behavior.

If the same students play both treatments, order creates learning and experimenter demand. State that limitation. Simultaneous treatment assignment avoids some order effects but requires enough groups and clear coordination. A class does not require a perfect experimental design, but it should

not present a pedagogical comparison as a causal estimate.

10.4 Discussion questions

1. Why can a larger individual harvest coexist with lower group profit?
2. At what remaining stock is benchmark growth largest, and why?
3. What information is required to calculate the full effect of effort?
4. How does the prediction change from one to ten seasons?
5. What is the difference between uncertainty about biology and uncertainty about others?
6. Why might communication work without sanctions?
7. Which pattern could distinguish missing information from an appropriation incentive?
8. How should a community react differently to permanently lower r and a temporary shock?
9. Is a terminal bonus equivalent to ownership? Which rights are missing?
10. How might quotas be allocated, and who would gain from that distribution?

Exercises for instructors and students

11.1 Exercise 1: reconstruct a season

Give students initial stock 80 and efforts 2, 3, 5, and 10. They calculate total effort, desired harvest, cap, individual harvests, remainder, growth, next stock, and ECU. They must label every unit. The solution has total effort 20, harvest 32, remaining stock 48, and growth $0.5(48)(0.52) = 12.48$, giving next stock 60.48. Individual harvests are 3.2, 4.8, 8, and 16.

Then have everyone halve effort and repeat. Compare current profit and future stock. The purpose is to recognize the causal chain, not memorize numbers. Common mistakes include applying growth to initial rather than remaining stock and dividing harvest equally when effort differs.

11.2 Exercise 2: growth curves

Calculate $G(R)$ at remaining stocks 0, 20, 40, 50, 60, 80, and 100 with $r = 0.50$ and $r = 0.25$. Plot both curves. Ask what changes in height, what does not change in the location of the maximum, and why a slow-growing species requires less extraction for a comparable path.

Connect the curves with the report. Below a remainder of 50, another stock reduction lowers growth as well, potentially producing slow recovery. Near 100, moderate harvest may increase growth by relaxing capacity pressure, but that does not mean every harvest is efficient. Price, cost, and future value still matter.

11.3 Exercise 3: best response and externality

Fix stock and the efforts of three other fishers. Each student calculates personal ECU for effort choices 0–10. Then compare the private best response with the choice that maximizes group current earnings, holding others fixed. Identify the effect on other current harvests and the separate effect on next stock.

The exercise shows two externalities: contemporaneous rivalry and an intertemporal cost on the resource. The second does not create later payments in the one-season version, although biomass is reported. Both matter in ten seasons. Advanced students can represent the dynamic game without being required to solve it analytically.

11.4 Exercise 4: evaluate an institution

Each team chooses communication, forecast, or bonus and states an expected mechanism, primary indicator, result that would challenge the prediction, and possible unintended effect. Communication might reduce effort but could coordinate a high recommendation; a forecast can inform but also anchor; a bonus can preserve stock but pay groups that would have conserved anyway.

Compare these plans with class data. Grade the connection between mechanism and indicator rather than whether a prediction happened to be correct. The exercise teaches hypothesis formation before observation and discourages retrospective explanations that fit every outcome.

11.5 Exercise 5: design quotas for the next family

Ask each group to design a total quota, allocation rule, and enforcement mechanism. They must decide whether rights are equal, historical, auctioned, or tradable; what happens after a stock decline; who monitors; which sanction applies; and how new entrants are treated. Identify which components can be implemented in oTree and which report variables are needed.

This exercise connects the current family to the next without mixing treatments. Open access establishes the problem; quotas allow analysis of a proposed solution and its distributional consequences. Separate families preserve flexibility for instructors who need only the dilemma or only the regulatory instrument.

Interpretation, limitations, and responsible use

12.1 What one session can establish

A session displays choices under known rules and their mechanical consequences. It supports statements about effort, stock paths, and patterns among treatments within the class. Theory can identify mechanisms compatible with those observations.

It cannot establish that students represent actual fishers, that an institution will work identically in a particular community, or that a small difference was caused by treatment. Experience, culture, stakes, natural communication, monitoring, norms, and real ecology are much richer. Academic references situate the exercise but do not turn a classroom demonstration into external evidence.

12.2 Observation and independence

Choices are recorded by person, but stock and many outcomes are determined by the fishing ground. Four rows from one group share treatment, history, and shocks and are not four independent observations of an institutional effect. For comparisons, the minimum independent unit is usually the fishing ground. Ten seasons do not provide ten independent replications either, because states are dynamically linked.

Explain this structure when using the activity to teach methods. A graph with forty decisions can come from one ground and provide less evidence than four independent groups. The report emphasizes description; exported data permit appropriate analysis when enough units exist.

12.3 Anonymity, accessibility, and debriefing

Do not identify anyone who selected high effort or departed from a recommendation. Labels such as “overharvester” expose students and weaken learning. Discuss profiles, distributions, and groups. During later conversation, no one should be required to reveal a private choice.

The interface uses text, numbers, icons, and color so color is never the sole channel. Permit zoom, read general information aloud when needed, and provide additional time without singling anyone out. Confirm keyboard and screen-reader access in the laboratory. A disability or technical difficulty must not become a behavioral observation.

The debrief must state that parameters are artificial and ECU are not an automatic measure of environmental welfare. If the activity is graded, assess understanding and reasoning rather than

effort choice. If it is used for research, apply the relevant ethics, consent, and data-management protocol.

12.4 Common interpretation errors

High final stock does not prove that welfare was maximized; the group may have forgone valuable harvest. High first-season earnings do not establish a superior path. Lower effort after a shock does not prove altruism; it may be a productive response to lower stock. A low recommendation does not ensure compliance. Higher price can raise gross revenue and lower net rent. The same average may conceal opposite distributions.

Another mistake is to attribute all overexploitation to common ownership. Moxnes highlights mental models; the Ostrom tradition demonstrates institutional diversity; Clark shows that economic variables can favor extraction even for a single manager. Present the mechanisms as complementary, and use treatments to separate some of them.

12.5 From the classroom to policy

To transfer learning to a real case, first identify the resource, users, and time scale. Then list formal and informal rights, monitoring arrangements, alternative livelihoods, and ecological uncertainty. Only afterward compare the real structure with the game. This sequence prevents the claim that every fishery is a homogeneous ground with four identical users.

A policy can change effort, technology, access, net price, or future value. It may also redistribute rent and risk. A quota that protects stock can disadvantage users receiving few initial rights; a subsidy for cleaner equipment can expand total capacity; a protected area can displace effort. The model locates a margin, but evaluation requires additional distributional and institutional evidence.

As a closing task, request a conditional recommendation: “If the main problem is X and we observe Y, I would propose Z; I would change the recommendation if W appeared.” Conditional language is more rigorous than selecting a favorite policy and requires the student to state mechanism, evidence, and inferential limit.

Data and reproducibility

13.1 Exported variables

The export records language, version, treatment, round, position, effort, recommendation, initial stock, shock, post-shock stock, individual and group harvest, remainder, growth, next stock, revenue, cost, current ECU, discount factor, credited ECU, bonus, and cumulative earnings. Session variables document horizon and matching.

Preserve the original export and analyze a copy. Record configuration, date, course, and incidents. Do not combine sessions from different domains merely because names look similar; family isolation improves traceability. Any public analysis should document commit version, exclusion rules, and aggregation level.

Checkpoint

A delivery is ready when numerical logic passes tests; Debug info is absent; all rooms filter; Spanish and English texts have parity; every page preserves the institutional visual system; the report is anonymous; screenshots come from the current version; both guides compile; each PDF exceeds 7,000 words; every page has been inspected; and Git contains code, documentation, and editable sources.

13.2 Technical checks

If a link returns **Not Found**, confirm that the local server is running on port 8046 and that the room path is exact. If a participant remains on **Please wait**, check Monitor; another member usually has not submitted. If “No more pages left” appears, confirm that FinalSummary is in the current page sequence and the session uses the current configuration.

If Demo lists other families, check `GAME_FAMILY=renewablefishery`. If a room contains more than 3 or 8 options, inspect its prefix and filter. If Debug info appears, confirm `OTREE_PRODUCTION=1`. If Report cannot be released, verify that all expected observations are complete rather than modifying data to force the button.

13.3 Pre-deployment validation

Run bot tests for all 22 configurations. Complete one Spanish and one English session and inspect translation, comprehension, and results. Verify room counts 3, 3, 8, and 8. Confirm that Report is hidden during play and available afterward. Export data and ensure they belong only to this

instance. Server Check should show production mode, authentication, and the intended database.

13.4 Minimum technical record

For every deployment, retain date, commit, oTree version, `GAME_FAMILY` value, domain, port, database, and verifier. Record bot-test result, room counts, one Spanish session, one English session, and a data export. Passwords belong in the laboratory's secure credential manager and never in this guide, the repository, or a chat.

If an update fails, this record supports returning to the previous commit and restarting only this family's process. Do not erase the database as the first response. Preserve exports and determine whether the fault lies in code, environment, proxy, or DNS. A route that works locally but not in production points toward infrastructure; a missing local configuration points toward code or filtering.

The verifier should date and sign a short checklist. This practice does not replace monitoring, but it establishes which version reached the classroom and prevents an informal test from being mistaken for an approved deployment.

Glossary and instructor references

14.1 Glossary

Biomass or stock: amount of the resource available at a point in time. **Harvest:** flow removed during one season. **Effort:** fishing input chosen by a participant. **Carrying capacity:** largest stock supported by the environment under the logistic rule. **Growth:** natural increment after harvest. **Resource rent:** economic surplus associated with resource productivity, net of costs. **Open access:** regime without individual extraction rights inside the game. **Externality:** effect of a decision on others' earnings or opportunities that the decision maker does not fully incorporate. **Discounting:** reduced weight on future outcomes. **Resilience:** capacity to absorb disturbance and recover. **Experimental unit:** independent level receiving treatment, usually the fishing ground here.

14.2 Readings and their relation to the activity

Gordon (1954) provides the classic economic model of a common-property resource and rent dissipation. Schaefer (1954) supplies the biological structure connecting population, effort, and yield. Clark (1973) integrates dynamics, prices, and discounting to explain why economic exploitation can reduce a stock severely.

Moxnes (1998) shows that mistaken bioeconomic perceptions can contribute to overexploitation and motivates the forecast treatment. Janssen (2010) explains how ecological dynamics enter common-pool-resource experiments. Ahn, Ostrom, and Walker (2011) document variation and cooperation in a broad participant sample. Owusu, Kulesz, and Merico (2021) show that harvester communication can support sustainable fishing behavior. These works motivate mechanisms; the application's numerical parameters are an original teaching adaptation.

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- Schaefer, M. B. (1954). Some aspects of the dynamics of populations important to the management of the commercial marine fisheries. *Inter-American Tropical Tuna Commission Bulletin*, 1(2), 27–56.

Printable checklist

A.1 Preparation

- I defined the question, treatment, language, horizon, and participant count.
- I confirmed a multiple of four and prepared a plan for extra students.
- I verified the domain, family, four rooms, and counts 3/3/8/8.
- I tested Welcome, Comprehension, Effort, Wait, Results, Final Summary, and Report.
- I opened Monitor and Report and confirmed the report is protected.
- I reserved time for a complete calculation and aggregate feedback.

A.2 Implementation

- I shared only the room route and asked students to open one tab.
- I explained mechanics without recommending effort or announcing a hypothesis.
- I answered questions publicly and preserved choice privacy.
- I waited for all expected observations before revealing results.
- I described choices, dynamics, and earnings before evaluating institutions.

A.3 Closing

- I separated observed results, compatible mechanisms, and causal claims.
- I explained simulation limits and differences from real fisheries.
- I exported and labeled data only if needed.
- I recorded incidents, code version, and notes for the next session.