An Experimental Economic History of Whalers' Rules of Capture[‡]

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Abstract: This paper uses a laboratory experiment to probe the proposition that property emerges anarchically out of social custom. We test the hypothesis that whalers in the 18th and 19th century developed rules of conduct that minimized the sum of the transaction and production costs of capturing their prey, the primary implication being that different ecological conditions lead to different rules of capture. Holding everything else constant, we find that simply imposing two different types of prey is insufficient to observe two different rules of capture. Another factor is essential, *c'est-à-dire*, that the members of the community are civil-minded.

Key Words: property rights, endogenous rules, whaling, experimental economics

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> [W]e may hence too discover the Falsity of that Vulgar Saying, *Mine* and *Thine* are the cause of all the Wars and Quarrels in the World. For on the contrary the Distinction of *Mine* and *Thine* was rather introduc'd to prevent all Contention.
> –Samuel Pufendorf (*Of the Law of Nature and Nations*, Book IV, Chapter IV, Section VII)

I. Introduction

The institution of property solves a fundamental problem in human relations, namely it defuses costly belligerence. When in direct competition for a resource, people are not outright pugnacious at every turn because there are costs as well as benefits to any fight. These personal costs induce agonists, through a gradual process of feedback and innovation, to adopt individual rules of restraint for orderly engaging their competitors. Little, however, is understood about how these general rules to curb quarrelsome impulses emerge at the level of the individual and subsequently develop into full-blown social institutions modernly recognizable as forms of property.

Calling property an "institution" is somewhat specious, for it evokes notions of something being deliberately instituted by someone. And it is this notion regarding the origins of property that has been the source of considerable philosophical debate since before the Enlightenment. Whereas Hobbes (1651), Bentham (1802), and Sened (1997) would argue that an exogenous state is the sole creator and guarantor of rights to property, others such as Pufendorf (1672), Hume (1740), and Demsetz (1967) contend that property endogenously evolves by graduated habit and custom, indeed the result of human action but not the grand product of conscious design.

Ellickson (1989, 1991) attempts to disprove the former "legal-centralist" view of property with a pointed example, the Anglo-American whaling industry in the mid 18th to mid 19th centuries. During its heyday (and still today), whalers competed for prey in the open seas beyond the reach of any state-instituted and -enforced rules of capture, and yet the community of whalers established clear rules of capture. Not just any rule would do, however. Ellickson builds a case for the hypothesis that members of the whaling community developed norms that were "wealth-maximizing," i.e., whalers developed rules of conduct that minimized the sum of the transaction and production costs of capturing their prey. A primary implication of this hypothesis is that different ecological conditions, in this case different types of prey, led to different rules of capture. A further implication is that there also existed a set of counterfactual norms that did *not* emerge. By examining the ecological sensitivity of the rules that whalers did adopt and the nontrivial number of rules that they could have but did *not* develop, Ellickson concludes that whaling norms were in fact "consistently sensitive to both production incentives and transaction costs and varied in utilitarian fashion with the conditions prevailing in different fisheries" (p. 95).

Our project focuses on two specific rules that emerged from hunting two different types of whales (Ellickson 1989, 1991). British whalers in the 18th century hunted right whales, a type of baleen whale, off the coast of Greenland and developed a rule that has been succinctly summarized as *fast-fish, loose-fish*. If a right whale was held fast to a boat via harpoon or other apparatus, the right to that whale belonged to that boat. If a whale was not attached to a boat or escaped by ineptitude or chance, the loose fish was fair game for any boat.[1] This rule worked well because right whales are slow swimmers, not particularly feisty, and not prone to dive (and take an attached boat down with it). On the other hand, sperm whales, the prey of American whalers, swim faster, fight harder, and could drag an attached 19th century whaleboat under water. Hence, the *fast-fish, loose-fish* rule was too costly to be employed to hunt sperm whales. The rule that developed for this prey was called *iron holds the whale*. The primary difference between the two rules is that with the latter rule, the harpoon did not have to be attached to the boat. As long as the boat remained in pursuit of the harpooned or lanced whale, the whale remained the property of the pursuer. If a boat failed to remain in reasonable proximity and/or could not defend its intention of taking the whale, the next affixer could stake claim to it.

Faced with this historical contravening evidence, how might a (legal-centralist) skeptic respond? By criticizing the empirical method of inquiry, for as Ellickson (1991) anticipates and so politely characterizes it himself, "[a]ny ex post explanation risks being too pat" (p. 205). Such repositioning of the argument is not unique to ex post explanations of questions in economic history and is simply an equivocation on the fundamental Duhem-Quine problem of inquiry. When faced with specific empirical evidence on a question of science, is it the theory that fails or is it the auxiliary assumptions in conducting the particular empirical analysis that we reject? Either is an option, the choice of which is constrained only by our personal intellectual commitments (Polanyi, 1958).

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[1] Or, as one of our subjects says, it's "free game" when a "circle" (whale) escapes.

This paper uses a laboratory experiment to acutely probe, ex ante, the proposition that property emerges anarchically out of social custom. Ellickson has only one realization of whaling history on which to support his claim. To that we add 24 independent observations of 144 undergraduates from two universities who are some 85 years removed from 1924—the year the last wooden whaleship left New Bedford harbor (it ingloriously sank).[2] This paper, however, is not just a test of Ellickson's hypothesis of wealth-maximizing norms with participants who are unfamiliar, if not completely ignorant, of 19th century whaler norms. Ellickson's seminal contribution is highlighting the crucial role that specific ecological conditions play in the emergence of property norms. Our experiment directly investigates this hypothesis by creating two virtual ecological conditions of prey that differ in an arguably subtle way. Yet differences in prey are not the only ecological factors that shape rules of capture. Any rule that emerges must also operate in combination with the diverse dispositions and impulses of the whalers themselves. Our experimental design allows us, like Ellickson, to assess which rules do *not* emerge, but crucially, it also enables us to observe how anarchically unstable and hence inefficient groups respond to different types of prey vis-à-vis stable, wealth-maximizing groups, both of whom experience precisely the same change in ecological conditions. In other words, in addition to observing how wealth-maximizing groups address changes in prey, we will also observe the interaction of counter-sociable groups with directly comparable changes in ecology.

Our paper is organized as follows. In Section II we present our original between-group experimental design, procedures, and hypotheses. Section III then reports the results from our first two treatments. Based upon what we observed from the initial treatments, we introduce in Section IV the design and results for a final within-group treatment. This treatment pins down what we can learn from this experiment. The paper concludes with a discussion and closing remarks in Section V.

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[2] See Dolin (2007) for a fascinating history of American whaling from 1614-1924. The cast of characters includes John Hancock, James Fennimore Cooper, and John Adams. Davis, Gallman, and Gleiter (1997) document a detailed economic history of whaling for the period of 1816-1906.

II. Experiment Design, Procedures, and Hypotheses

II.A. Preliminaries

While Ellickson's observations on informal whaling rules serve as the inspiration for the basic structure of our experimental design, we are under no illusion that we are capturing *in toto* the conditions that naturally occurred over 150 years ago. (Our Internal Review Board vetoed bringing any whales to campus for our subjects to hunt.) The guiding principle behind the choices of our numerous abstractions is parsimonious control, so our virtual whale hunts differ in many ways, both intentionally and unintentionally, from those that occurred historically. Our objective is to observe how differences in an exogenously imposed ecology affect the rules that emerge for extracting a prey that lies open to any and every person in a randomly assigned community. Given the large number of detailed parameters, we recommend reading the experiment instructions in Appendix A before reading the rest of this section.

II.B. Environment

Each subject is given control over a colored stick figure that identifies him or her by his or her color name to the other subjects in the session (see Figure 1a). Each experimental session consists of 26 periods of three minutes each. Each period is further subdivided into two 90-second phases. In phase A, which is called the "Gathering" phase in the instructions, subjects can move around an open "gathering" area shown in the middle portion of Figure 1a by left clicking anywhere in the gathering area. Left clicking at anytime will immediately change their direction and distance of travel taking the stick figure to that spot in the coordinate plane.[3] Subjects have limited vision of the gathering area, as indicated by the gray 325-pixel diameter that surrounds each stick figure.

Each session is comprised of six subjects. To allow the subjects time to familiarize themselves with their task and forge a potential relationship, we use a "build" design similar to previous experiments that gradually increases the group size (Weber 2006; Crockett, Smith, and Wilson 2009). Subjects begin the experiment in three paired groups; after period 13, all three pairs merge into one group of six, which remains intact for the duration of the session.

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[3] Each pixel is one unit on a coordinate plane that comprises the gathering area.

During the first 60 seconds of phase A, the computer software randomly spawns white circles for the subjects to gather. A total of four circles, or two per person, randomly appear in the gathering area when the subjects are in pairs. After the subjects merge to a single group of six in period 14, a total of ten circles appear, so that two cannot be evenly distributed to each person within a period. In what we will call the *Right* treatment, circles move at a pace of 50 pixels/second; stick figures only move at a speed of 25 pixels/second. The circles are always moving in a straight line to a randomly chosen location unbeknownst to the subjects. After the circle reaches its destination, it chooses another immediately and moves toward it. The circles also dive and surface.[4] To get a sense of the cumulative effect of these parameters, imagine that you control a stick figure that you can move around an environment populated by other stick figures and also white circles that, *either* travel in and out of your limited field of vision at a pace that is faster than you move, *or* occasionally simply fade (dive) out of sight.

Each participant's task is to earn money by "gathering" circles. We first discuss the simplest case for gathering circles and then move on to more involved cases. Throughout the experiment subjects can purchase "lines" in the previous period's phase B. A subject can attach a line to circle by right clicking on a circle within a 175-pixel diameter of their stick figure. A colored line encircles each stick figure and denotes their "line-throwing" range. If the subject misses the circle, (remember that the circles are constantly moving) the word "Miss" appears where the line failed to attach to a circle. After a subject "attaches" a line to a circle, it takes 5 seconds to pull in the circle, during which time the circle no longer moves and the line continues to connect the stick figure to the circle. After 5 seconds, the computer determines with a 75% probability whether the circle will be successfully "pulled in" by the subject. If the subject is successful, the circle appears in the designated cargo boxes that surround the gathering area. A whole circle is worth 100 US cents and can be redeemed in Phase B of the experiment. Thus, in the first 39 minutes of the experiment a pair of subjects can earn a total of $52 between them. In the last half of the experiment, there is $130 of prey roaming the gathering area.

If by a 25% chance a circle is not caught, then the stick figure and circle are free to move around. At that instant there is an independent 25% chance that the circle will stop moving

[4] More specifically, there are four status phases of circles: On-the-surface, Diving, Surfacing, and On-the-bottom. If a circle is not On-the-bottom, then a line can be attached to it. A circle takes 5 seconds to dive or to surface and continue to move and pick new destinations when On-the-bottom. Each second a circle is On-the-surface, there is a 10% chance it will dive. There is also a 25% chance each second a circle is On-the-bottom that it will surface.

altogether. Such a "dead" circle can be caught with a 100% probability by the next line or lines that attach to it for the same value of a "live" moving circle. After each successful or unsuccessful throw, a stick figure must "cool down" for 5 seconds before it can throw another line. If a circle survives an initial strike and does not die, any subsequent strike on this moving circle will be successful with a 90% probability. After the first strike the circle also slows down to roaming at 37.5 pixels/second, or 75% its original speed. If a circle survives a second and any subsequent strikes, it permanently slows down to 25 pixels/second, the speed of the stick figures. Finally, circles die at a rate of 50% the instant after all second and subsequent strikes are unsuccessful.

The more involved cases arise when one subject is attached to a circle and additional subjects also right click and attach a line to the same circle. The result of this process is that any or all of n attached subjects can successfully catch a circle. As mentioned above, when only one subject catches a circle only that subject can redeem it for 100 cents. However, when $m \leq n$ subjects successfully catch a circle (each person has its own independent probability of being successful), each successful subject only receives a pie-sized piece of the circle worth $1/m^2$ of the total value of the circle. The remaining amount of the circle, $(m - 1)/m$, is lost as waste from the fight for the circle. For example, if two subjects successfully catch the same circle, each receives a quarter of a circle worth 25 cents, and 50 cents is lost to the ether. If three subjects catch a circle, each receives 11 cents and 67 cents is lost. The fractions lost are displayed in the box in the bottom right portion of Figure 1a under the heading, "Portions Lost." The salient monetary losses are important to keep in mind when evaluating the observed amount of double, triple, quadruple, and even occasionally quintuple strikes that are made on attached circles in Section III.

In phase B, which is called the "Interim" phase in the instructions, subjects can redeem caught circles and any portions thereof for money by right clicking and dragging the circle to the "Buyer" on the right side of the screen (see Figure 1b). They can also transfer circles or money to any other subject, and they can use the chat room in the center of screen to communicate with each other. To transfer money, subjects click on the ¢-tab in the cargo box, left click the amount to add to the total to send, and the drag the amount indicated to another subject's cargo area. All transfers of circles and money are publicly recorded in the chat room. Finally, during the Interim phase subjects can purchase new lines for use in later periods. All transfers of circles and whales are publicly recorded in the chat room.

There are two types of lines, regular and colored, which cost 10 and 20 cents, respectively. The lines have exactly the same capabilities in catching a circle, the only difference, apart from the cost, is that a colored line will change the color of the circle to the color of the thrower, regardless whether the line is successful or not. If another stick figure attempts to attach a colored line to a colored circle, then both colors are displayed in equal proportion on the circle. So, for example, if *Red* throws a colored line at a white circle and with a 25% chance it gets away, one red circle will roam the gathering area among the other white circles. If *Blue* subsequently attaches to the red-colored whale with a colored line, half of the circle will become blue and half remains red. If while *Blue* is attached to the half-red, half-blue circle, *Green* comes along and attaches a colored line to the same circle, it becomes one-third red, one-third blue, and one-third green, and so forth. Regular lines have no coloring effect on white or colored circles. We will discuss the reasoning behind this aspect of the design in the hypothesis subsection below.

Importantly, subjects are only told that circles must be redeemed in order to accumulate earnings to be paid in cash at the end of the experiment; otherwise they are not told why transferring, chatting, or using one type of line or another might be advantageous. The reader will also note that the minutiae of the circle movements and probabilities are not explained to the subjects in the instructions. These are aspects of this novel environment that they must learn from trial-and-error.

II.C. Treatments and Hypotheses

As mentioned above, our objective is to exogenously vary the ecological conditions of the prey to observe how this affects which rules, if any, predominantly emerge to minimize losses from the whalers' conflicting interests. The parameters described in the previous subsection refer to what we will call the *Right* (whale) treatment. In the second treatment, which we call the *Sperm* treatment, the prey is more difficult to catch. Our sperm whales move 50% faster than right whales, or three times the speed of the whalers.[5] Once first harpooned, a sperm

[5] Henceforth we shall often refer to circles as "whales," subjects as "whalers," etc. We proceed in this manner purely for convenience and not because we have forgotten our remarks at the beginning of section *II.A*. Though one

whale is successfully pulled in only 25% of the time, which is one-third the probability of a right whale being pulled in, and sperm whales only die with 10% probability after the first strike. In both treatments, each whole whale is worth 100 cents; the same number of whales appear in the gathering area each comparable period; and all harpoons cost and function the same. Table 1 summarizes the parameters for both treatments.

We designed the two types of harpoons described to allow our subjects to more clearly express the two different rules of capture that Ellickson studied in whalers over 150-250 years ago: *fast-fish, loose-fish* and *iron holds the whale*. If our subjects adopt a *fast-fish, loose-fish* rule (we think it's safe to say that 99% were unaware that their computerized task crudely models Anglo-American whaling), there is no need to pay twice as much for colored harpoons; a colored line simply leaves money on the table. In contrast, a subject who adopts the *iron holds the whale* rule may believe that there is at least a value of 10 cents to marking a whale as his, which is 10% of the redemption value of a whole whale and 40% of the redemption value of a whale split two ways. A bright, fully colored circle provides stark evidence to back up any claim that a particular whaler affixed the first harpoon. This rule rewards the investment of the first harpoon that subsequently slows a whale down and makes it more likely that subsequent harpoons will successfully pull in the whale. Recall from Table 1 that the first harpoon in a sperm whale is only successful 25% of the time, whereas any subsequent harpoon is 75% successful. While regular lines also equally reduce the speed and increase the probability of taking a whale with a future strike, there is no evidence of who took the risk (bore the cost) of affixing the first harpoon. We chose to conclude the second half of a session with a group of six subjects to make it difficult for the subjects to keep track of who threw which regular harpoons into which whale.

Of course, it is possible that our subjects do not adopt either of these rules, nor for that matter any rule of capture. A free-for-all is feasible, and not at all unanticipated given the rampant theft that Kimbrough, Smith, and Wilson (2009) report in their virtual communities. We can determine whether any rules of capture are present by the number of harpoons affixed to

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subject refers to the circles as "whales" in the chat room, the majority of subjects simply refer to them as "circles;" others call them "balls," "bubbles," "eggs," or "fish." Subjects also refer to the task confronting them in several ways, variously likening it to fishing, butterfly catching, and participating in an Easter egg hunt. This demonstrates that even though experimenters may implement what they consider to be neutral instructions, subjects provide their own context based upon their personal life experiences.

a whale that is attached to a whaler. After an initial harpoon strike, every subsequent strike on an attached whale risks wasting $100(m-1)/m$ cents.[6] Thus, subsequent strikes can "take" $100 - 100/m^2$ cents from a successful first harpooner. We fully expect this costly behavior. The question is whether we will observe a spontaneous order emerge out of the initially unruly and thus inefficient environment. Based upon the random assignment of subjects to treatments, our aim is identify and characterize any spontaneous orders. At this point, it is not clear whether the delicate differences between the *Sperm* and *Right* treatments in Table 1 will lead to similar social orders, different social orders, or no social order at all.

However, we do have an ex ante hypothesis that we will observe more *fast-fish, loose-fish* behavior in the *Right* treatment than in the *Sperm* treatment, and complementarily, more *iron holds the whale* behavior in the *Sperm* treatment than in the *Right* treatment. Within the *Right* treatment, we also predict more *fast-fish, loose-fish* behavior than *iron holds the whale* behavior, and vice versa, more *iron holds the whale* behavior than *fast-fish, loose-fish* behavior in the *Sperm* treatment. Finally, we do not expect widespread use of a third rule that is feasible in our experiment, namely, *split ownership*, a rule whereby everyone gets an equal share of the total earnings from a whale hunt. This potential rule of capture is why our design allows subjects to transfer whole whales or cash to other subjects during the Interim phase. However, we anticipate that this rule will be too costly for subjects to widely adopt. To reiterate:

Ex Ante Hypothesis**:** Fast-fish, loose-fish *will be more prevalent in the* Right *sessions than in the* Sperm *sessions*. Iron holds the whale *will be more prevalent in the* Sperm *sessions than in the* Right *sessions*. *In the Right sessions, there will be more* fast-fish, loose-fish *than* iron holds the whale. *In the* Sperm *sessions, there will be more* iron holds the whale *than* fast-fish, loose-fish. Split ownership *will not be widely employed in either treatment*.

II.D. Procedures

We conducted six replicates of each of the *Right* and *Sperm* treatments. These 72 subjects were recruited from the general student body of a large state university. We discuss a third treatment in Section IV for which we recruited another 72 subjects at a midsize private university. (In Section IV we also report that the change in subject pools has no statistical effect

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[6] Such waste is not guaranteed since there is a 10% (25%) chance that the subsequent strikers will be unsuccessful in pulling in a share of the whale for themselves in the *Right* (*Sperm*) treatment.

for the first 13 periods in which the parameters of the third treatment very nearly match those in the *Right* treatment.) No subject participated twice, and all subjects were randomly recruited via an electronic email system and paid $7 for showing up on time. When subjects arrived in the laboratory they were seated at visually isolated computer terminals where they privately read through self-paced instructions. Subjects were free to ask questions during the instructions and throughout the experiment. Not including the show-up payment, mean earnings for all 144 subjects were $27.59 and paid privately at the conclusion of the session which lasted less than the two hours for which they were recruited.

III. Results from the *Right* and *Sperm* Treatments

Each harpoon thrown suggests which rules might be guiding the actions of the player who threw the harpoon. While no social scientist can peer into the minds of his or her subjects to ascertain whether a given rule governs their behavior, or even to determine whether their actions simply do not contradict the rule, we can use trends in the observed proportion of harpoon throws that appear to follow a specific rule as tethered evidence that the rule is used relatively more than other potential rules. Specifically, we classify each harpoon thrown into one of four categories according to the rule that it suggests: *fast-fish, loose-fish*; *iron holds the whale*; *deadweight loss*; and *unknowable*. The categories are mutually exclusive and exhaustive. In the following explanation of these categories, we use feminine pronouns in reference to the first person to strike a whale and masculine pronouns for subsequent strikers.

First, while anyone is attached to a whale, regardless of the type of line she is using, a subsequent strike on the whale clearly does not demonstrate wealth maximization, as this behavior may waste portions of the whale depending upon the random probability that both parties are successful in pulling it in. Thus, any of these interloping harpoons are counted as *deadweight loss*.

If a subject finds an uncolored whale and strikes it with a colored line. This harpoon suggests that she is attempting to convey to the other whalers that she struck the whale and should accordingly be classified as *iron holds the whale*. If she is behaving according to *fast-fish, loose-fish*, then she should use the cheaper, but equally effective regular lines since she would have no incentive to mark the whale under *fast-fish, loose-fish*.

Suppose that a first striker who used a colored line, and any interlopers, are all unsuccessful in capturing a whale. Now there is a free-roaming colored whale. If the first striker harpoons it again, then this suggests that she is behaving according to *iron holds the whale*. In this case, the type of line used does not matter because she already marked the whale with her initial strike. On the other hand, if someone else finds this colored whale before the first striker does and harpoons it with a regular line, then it is unclear which norm he is following unless the circle is captured by him. If the second striker respects the property right claimed by the first striker when she colored the whale, he will transfer the whale or some amount of money to her, perhaps keeping a "finders" fee for himself. This harpoon is then coded as *iron holds the whale*. If he does not transfer anything to the first striker, then the harpoon is classified as *fast-fish, loose-fish*. If he is unsuccessful in pulling in the whale, then we cannot predict what his intentions were and must categorize the strike as *unknowable*.

If a second striker of a colored whale uses a colored line on the already colored free-roaming whale, then this does not immediately suggest either *fast-fish, loose-fish* or *iron holds the whale*. The second striker should not use a colored line if he is following *fast-fish, loose-fish* because a regular line is an equally effective but less expensive alternative. Thus, the strike is classified as *unknowable* if he captures it with a colored line and does not transfer wealth to the first striker.[7] Likewise, the second striker should not use a colored line if he is following *iron holds the whale* because it is now unclear who the original claimant is in the event that he is unsuccessful and a third player then finds and successfully captures this multicolored whale. However, if the second striker captures the whale and transfers money or the whale to the first-striker, then that strike is classified as *iron holds the whale* because the transfer of wealth indicates that he acknowledges the first striker's property right.

In comparing across treatments, we normalize the number of harpoons in the *Sperm* treatment based upon the expected number of harpoons it takes to successfully pull in a whale. Table 1 reports that the expected number of harpoons per whale in the *Right* and *Sperm* treatments, is approximately 1.2697 and 1.9577, respectively. Thus, for the purposes of directly comparing the two treatments, we scale down the number of *Sperm* harpoons by dividing the totals by the ratio $\frac{1.9577}{1.2697} = 1.549$. Likewise, for all data presented for periods 1-13, unless noted to

[7] Of the 3,091 harpoons thrown in the *Right* and *Sperm* treatments, only 21 in each treatment are classified as unknowable and hence we do not consider this category in any of our analysis.

the contrary, we scale the total number of harpoons by the relative number of whales available; specifically, we divide pair data by $\frac{12}{10}$. We focus our analysis on data from the last 6 periods of the session, which is (approximately) the last half of the session for which the subjects were in one group of six.[8]

Before we present our quantitative findings, we first discuss a qualitative organization of the data. Figures 2 and 3 report the scaled number of harpoons thrown in the *Right* and *Sperm* treatments, respectively. The vertical line separates the pair data from the sextuplet data within a session. This change clearly and permanently increases the number of *deadweight loss* harpoons in the *Sperm* treatment and in three of the six *Right* sessions. In the three other *Right* sessions (2, 3, and 4), the number of *deadweight loss* harpoons spikes in periods 14-16, but then drops off substantially for the final quarter of the session. Of those, some are reported in the Interim phase to be accidents, for which they explicitly apologize, lest they be misunderstood as blatantly violating their customary rules of capture.[9]

Figure 4 summarizes the data from all 12 sessions for periods 21-26. The height of the bar is the total number of *deadweight loss* harpoons in the session. The colors of the bar represent the relative proportion of non-*deadweight loss* harpoons that are classified as *fast-fish,* loose-fish and *iron holds the whale*. First, note that there are only three sessions with a rather low number of *deadweight loss* harpoons. These sessions, all from the *Right* treatment, average 1.8 *deadweight loss* harpoons per period. The remaining three *Right* sessions average 8.0 *deadweight loss* harpoons per period. In other words, a *Right* session either clearly establishes customary rules of capture or it is a chaotic free-for-all; there are none in between. Lying between this gulf is the scaled number of *deadweight loss* harpoons in the *Sperm* treatment, the average of which is 4.3 harpoons per period. The *Sperm* sessions do not establish wealth-maximizing norms like the best sessions in the *Right* treatment do (though *Sperm*6 comes close). But they also do not double hit attached whales as frequently as the worst *Right* sessions do, perhaps because sperm whales move 50% faster than right whales.

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[8] There are no tests for which we find a significant result using the same test on all data for periods 14-26, but which is insignificant using the subsample of periods 21-26.

[9] As *Purple* in *Right*4 explains, "sometimes its a mistake that we nab eachothers…..we see('e)m at the same time and we(')re like the seagulls from finding nemo, MINE!"

The second summary observation of note is the predominance of *fast-fish, loose-fish* in *both* treatments.[10] In the *Right* treatment, two of the three more efficient sessions and two of the three less efficient sessions chiefly throw *fast-fish, loose-fish* harpoons. On the other hand, all six *Sperm* sessions throw more *fast-fish, loose-fish* harpoons than *iron holds the whale* harpoons, though the proportion is close in *Sperm*6, 51% to 49%. In the *Right* treatment, two of the three efficient sessions and two of the three inefficient sessions chiefly throw *fast-fish, loose-fish* harpoons. So when a session does not clearly establish wealth-maximizing rules of capture, the whalers respond quite economically by buying the cheaper regular harpoons. This, however, leaves us with a total of three sessions that conform to our predictions, split 2 to 1 between the two rules, and thus the need for the new hypotheses and concomitant treatment in Section IV. This brings us to our first formal finding.

Finding 1a: *There is no statistical difference in the scaled number of* fast-fish, loose-fish *harpoons thrown in the* Right *and* Sperm *treatments. There is also no statistical difference in the usage of* iron holds the whale *harpoons across treatments.*

Evidence: Using a Wilcoxon rank sum test comparing each independent session, we fail to reject the null hypothesis of equal number of *fast-fish, loose-fish* harpoons ($U_{6,6} = 19$, p-value = 0.5319, one-sided test). As the p-value greater than 0.5 indicates, contrary to our *Ex Ante Hypothesis*, the mean number of *fast-fish, loose-fish* harpoons is higher in the *Sperm* treatment than in the *Right* treatment. Out of an average of 97.5 harpoons thrown in the *Right* treatment in periods 21-26, 44.3 are consistent with *fast-fish, loose-fish*. In contrast, in the *Sperm* treatment 52.0 of an average of 87.1 harpoons thrown in periods 21-26 are *fast-fish, loose-fish* compatible. Likewise, we fail to reject the null hypothesis of an equal number of *iron holds the whale* harpoons ($U_{6,6} = 23.5$, p-value = 0.8030, one-sided test). Whereas the average *Sperm* session uses only 9.5 *iron holds the whale* harpoons over periods 21-26, the average *Right* session uses 23.8. The means are again in the opposite direction of our *Ex Ante Hypothesis*.

Finding 1b: *For the* Sperm *treatment, contra our* Ex Ante Hypothesis *every single session uses more* fast-fish, loose-fish *harpoons than* iron holds the whale *harpoons. Within the* Right

[10] Pooling the *Right* and *Sperm* treatments, we reject null hypothesis of equal *fast-fish, loose-fish* and *iron holds the whale* harpoons using a Wilcoxon signed rank test ($W_{12} = 68$, p-value = 0.0210, two-sided).

treatment, whalers use as many iron holds the whale *harpoons as they do* fast-fish, loose-fish *harpoons.*

Evidence: Using a Wilcoxon signed rank test comparing the paired number of *fast-fish, loose-fish* and *iron holds the whale* harpoons in each session, we fail to reject the null hypothesis of an equal number of harpoons of each type against the alternative of more *iron holds the whale* in the *Sperm* treatment ($W_6 = 0$, p-value = 1.000, one-sided test). The average *Sperm* session uses 42.5 more *fast-fish, loose-fish* than *iron holds the whale* harpoons, ranging from a low of 1.3 more to a high of 68.8 more. In the *Right* treatment, there is no statistical difference ($W_6 = 16$, p-value = 0.1562, one-sided). One *Right* session uses 49 more *iron holds the whale* than *fast-fish, loose-fish* harpoons and another uses 68 more *fast-fish, loose-fish* than *iron holds the whale* harpoons.

Before taking stock of what we've learned thus far, we assess in our second finding the degree to which *split ownership* rule is utilized.

Finding 2*: Very little cash and very few whales are redistributed among the whalers in the Interim period.*

Evidence: To examine the *split ownership* rule, we count the total value of the whales (w_t) and cash (c_t) transferred in period t. Table 2 reports the total amounts transferred in periods 14-26 by session. Very little is transferred. Using a Wilcoxon rank sum test, we fail to reject the null hypothesis of equal amounts transferred in the *Right* and *Sperm* treatments ($U_{6,6} = 26$, p-value = 0.2403, two-sided test). While one *Sperm* session engages in considerable redistribution during the Interim phase, none of the three wealth-maximizing *Right* sessions (2, 3, and 4) transfer a single penny of earnings amongst each other. It is not difficult to conclude that the *split ownership* norm is not our subjects' solution to their environment and the hunting task they confront.[11]

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[11] Because people can transfer money to each other, our experiment allows for positive rewards for good behavior. Negative sanctions are also possible by deliberately following a deviant around in order to harpoon the deviant's harpooned whales. The subjects in *Right*2 talk explicitly about this in period 15 and agree to target *Green* for his unruly behavior:

> Red: green you took mine! haha
> Orange: what ever happen to our deal??
> Green: hhahah im the best
> Green: im the master
> Teal: i know right

A skeptic's conclusion from Findings 1 and 2 might be to hastily dismiss these treatments as failures, so it is worth spending a few sentences reflecting on what we do "find" with these first two treatments. An advantage of a laboratory experiment vis-à-vis the naturally occurring world is its scale. We can learn from what we fail to observe in a way that is not possible outside the laboratory because we can create a further treatment to explore the clues in Figure 4 that hint at the emergence of social orders. And what are these clues? With slower, easier to capture prey, a community of six is either wealth-maximizing or it is not. Moreover, groups hunting faster, harder to capture prey split this difference. This is a nontrivial systematic result considering how subtle the changes are between the *Right* and *Sperm* treatments. So while the medians do not statistically differ in terms of the number of *deadweight loss* harpoons thrown ($U_{6,6}$ = 18, p-value = 1.000, two-sided test), we see potential; there are the outlines of social orders leading us to probe further and test our conjectured learning.

Finally, the chat room transcripts provide evidence that is consistent with such orders. In each transcript from *Right*2, -3, and -4 someone is observed to make an explicit appeal to a *fast-fish, loose-fish* rule. Immediately after the first period hunting as a sextuplet, *Orange* in *Right*2 proposes a *fast-fish* agreement:

Orange: lets agree to not hit once someone is on it alot of money is lost

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Blue: green u suck\
Green: i leraned the best from teal
Orange: ok everybody only steal from green
Teal: LOL
Blue: k
Red: haha
Green: hahah hey no fair
Purple: deal
Orange: deal
Teal: deal
Purple: haha
Orange: blue??
Orange: dude come on
Blue: sorry..
Purple: hahahaha
Orange: or dudet u in??
Orange: steal from green no one else
Orange: ??
Blue: i will
Purple: me 2
Orange: sweet

Eventually *Green* reforms. As Figure 2 shows, *Right*2 whalers threw many *deadweight loss* harpoons shortly after the sextuplet forms, but the number of double hits falls precipitously until the end of the session. We thank Robert Ellickson for his questions about the possibilities for negative informal sanctions.

Green: hahah
Blue: true
Orange: my partner and i did and it worked well
Purple: yup
Orange: agreed??
Blue: agreed
Orange: green??
Orange: teal??
Blue: lol
Purple: haha
Blue: guess not
Teal: yea that sounds like a plan

The subjects in *Right*3 also have a conversation in period 15 with explicit *fast-fish* and *loose-fish* provisions:

Orange: if you steal another person's hit we all lose 50
Blue: the pies getting smaller nam saying
Blue: lets spread out and not steal then cuz
Orange: so if somebody gets one it would be more advantageous to let them have it
Blue: yeah
Red: sounds good
Orange: and then it can be free game if they dsont catch it

There is similar case in period 14 of *Right*4 and everyone joins the conversation:

Purple: we missed a bunch
Green: i think its first tagged first served
Orange: yeah
Red: agreed!
Green: anything else is a hyge waste
Green: huge*
Blue: that would be better
Orange: we wont get any money if it splits
Orange: okay
Orange: first tag first serve!
Orange: good idea
Green: so everyone play nice? no pirates?
Purple: boo
Red: anyone know the purpose of the color?
Purple: yeah
Blue: what is it?
Orange: its pointless
Teal: yhoutght so
Green: anyone not for that?
Red: just more expensive
Teal: so first grab first get
Purple: sounds good
Orange: yup
Red: great
Teal: no fighting!
Orange: its really not worth it otherwise

Figure 5 is a snapshot of the *fast-fish, loose-fish* rule at work late in the *Right*4 session. This particular whale escaped from *Purple* and now *Blue* is attached to it. Even though it is within *Purple*'s range, her cool down time has expired, and she has yet to catch a whale this period, she acknowledges *Blue*'s right to it, as does *Red*. Also notice that all of the six previously caught whales are whole and white.

IV. *Sort*: A Within- and Between-Group Design

IV.A. Design and Hypothesis

At this juncture our project exemplifies what Latour (1999) pithily contends is subsidiarily true of all scientific hypothesizing, namely that "[s]cientists' predictions or previsions are always postdictions or repetitions" (p. 272). We now present a hypothesis that is unrepentantly grounded in postdictions of the *Sperm* and *Right* treatments. A rereading of Ellickson (1991) in light of our results reveals an understated but potentially important design parameter (emphasis added):

- "[A]ccording to the hypothesis, whalers *switched* to iron holds the whale because that rule's advantages in reducing deadweight losses outweighed its transaction-cost disadvantages" (p. 201).

- "[W]halers succeeded in [settling disputes without any guidance from American courts] during a time period in which all British decisions on whale ownership supported norms other than the iron-holds-the-whale rule [chiefly, fast-fish, loose-fish] that the Americans were *increasingly adopting*" (p. 204).

- "The critic might challenge the offered utilitarian interpretation on a number of grounds. First, the evidence suggests that whalers might have been wise to use the first-iron rule for sperm whales and the fast-fish rule for right whales. *They did not, and instead varied their rules according to the location of the fishery, not according to species*" (p. 205).

The first two quotations highlight that history matters. Among American whalers, *iron holds the whale* emerged spontaneously on the heel of another established rule, principally *fast-fish, loose-fish*. Moreover, this was a gradual process of change in response to increases in deadweight loss when the old rule no longer fit the ecology of the prey within a particular geographic community, as the third quotation specifies.

Our new treatment incorporates these observations. Our first aim for the new treatment is a feature that regularly predicts for our sextuplet communities the stable adoption of a wealth-maximizing rule of capture, whether *fast-fish, loose-fish* or *iron holds the whale* or neither. The second aim is to change our between-group comparison to a within-group comparison, i.e., change the type of whale from right to sperm within a session to reflect the historical chronology of the emergent norms. The former feature provides the important empirical foundation for investigating the latter feature of how established wealth-maximizing rules evolve to fit the ecological circumstances.

An implicit assumption of Ellickson's hypothesis is that whale boat captains were the survivors of an evolutionary process of trial and error that weeded out inefficient "whalers" that did not respect a community's rules of capture, whatever the rules may be or however they evolved. While 19th century whaling was not without its conflicts, disputes were not rampant. Ellickson writes that "[t]he international whaling community was a tight one… primarily because whaling ships commonly encountered one another at sea, and because whalers' home and layover ports were few, intimate, and socially interlinked. The scant evidence available suggests that whalers' norms of capture were internationally binding" (1991, p. 193).

Within the framework of our original design, we looked for an observable metric from the first 13 periods that would with which we could prevision (and replicate from past experience) a community-minded sextuplet for periods 14-26. In the *Right* and *Sperm* treatments we recruit six random people for a session and force them to interact in a community in which no one can be excluded, nor can anyone exclude themselves no matter their individual dispositions. For our last treatment, which we will call *Sort*, we invite 12 participants each for six sessions and then divide them into two groups of six after period 13: *Civil* and *Rude*.[12] Unbeknownst to the subjects, the *Civil* (*Rude*) group is comprised of the top (bottom) three pairs from periods 8-13 that have the fewest (highest) total number of strikes on attached whales. The idea is that this early behavior predicts whether or not the sextuplet will develop and abide by a rule of capture.[13] In a civil community, no single person sets themselves above the others by striking an attached whale; there is a mutual, or better, reciprocal, respect for evolved rules of capture. In contrast,

[12] We are using *civil* and *rude* in the common 18th century meaning of the words. Our modern lexicon does not have a better pair of mutual antonyms for our purposes. As opposed to the modern meaning connoting a citizen of a state, *civil* in the 18th century also meant "relating to a community of men, or to a man as a member of community" (Johnson 1755). *Rude* also conveyed a much harsher sense then than it does now, connoting "rough, savage, coarse of manners, uncivil, brutal" (Johnson 1755). Adam Ferguson in his *An Essay on the History of Civil Society* distinguishes rude societies from civil ones based upon the establishment of property. He describes people "[o]f rude nations, under the impressions of Property and Interest", as a "band of robbers, who prey without restraint, or remorse, on their neighbors" (1767, pp. 82-83). That aptly describes the whalers of *Right*1, -5, and -6. We could have used *communital* instead of *civil*, but the latter additionally conveys, just as *rude* does, how the community goes about their business in way that the former does not.

[13] Following Gunnthorsdottir, Houser, and McCabe (2007) and Rigdon, McCabe, and Smith (2007), we do not reveal to our subjects how their group is formed because our hypothesis is not about the rules of capture that people develop when they know they are combined with two other pairs who have the fewest or highest total number of strikes on attached whales in the previous six periods. Rather, the question is what rules, if any, spontaneous emerge amongst six similarly disposed people who happen to find themselves suddenly interacting with four other like-minded people.

rude members of a group put their own individual interests above the interests of others by striking attached whales.

For the second aim of this final treatment, we add an additional 13 periods to the end of the session. For the first 26 periods, right whales are the prey, but for the last 13 periods the prey switches without announcement to sperm whales in both the *Civil* and *Rude* groups. Because we have increased the number of periods by 50%, we decrease the value of a whale and the cost of harpoons by 40%. Table 3 compares the parameters of *Sort* treatment with the *Right* treatment. The only other difference is that we trim the Interim phase from 90 seconds to 60 seconds so that we can continue to complete the sessions within two hours. In the first two treatments, the Interim phase appeared to have about half a minute's worth a slack.

In general terms we hypothesize that *Civil* sextuplets will respond to the ecological change in whale type in a wealth-maximizing manner and that *Rude* sextuplets will not respond to the change or will respond in a way that is not wealth-maximizing. More specifically, the *Sort* treatment generates eight hypotheses, the findings for which we examine in detail in the next subsection:

- *Baseline Hypothesis*: For periods 1-13, there is no difference in the number of *fast-fish, loose-fish*, *iron holds the whale*, and *deadweight loss* harpoons in the *Sort* (in aggregate) and *Right* treatments.

- *Civil Pair Hypothesis*: For periods 8-13, *Civil* pairs throw fewer *deadweight loss* harpoons than *Right* pairs.[14]

- *Civil Sextuplet Hypothesis*: For periods 21-26, *Civil* sextuplets throw fewer *deadweight loss* harpoons than *Right* and *Rude* sextuplets.

- *Civil Fast-Fish, Loose-Fish Hypothesis*: For periods 21-26, *Civil* sextuplets throw more *fast-fish, loose-fish* than *iron holds the whale* harpoons.

- *Ellickson Hypothesis*: For *Civil* sextuplets, there is a structural break in the number of *deadweight loss* harpoons thrown when the prey changes from right to sperm whales in period 27.

- *Ellickson Counterhypothesis*: For *Rude* sextuplets, there is no structural break in the number of *deadweight loss* harpoons thrown when the prey changes from right to sperm whales in period 27.

[14] Except where noted, there are no tests for which we find a significant result using the same test on all data for periods 1-13 or 14-26, but which is insignificant using the subsample of periods 8-13 or 21-26.

- *Auxiliary Ellickson Hypothesis*: The usage of *iron holds the whale* harpoons is nondecreasing in *Civil* sextuplets.

- *Auxiliary Ellickson Counterhypothesis*: The usage of *iron holds the whale* harpoons decreases in *Rude* sextuplets.

IV.B. Results

Given that we have changed a couple minor parameters and the subject pool with the new *Sort* treatment, our first finding is important to establish that we have the same baseline in periods 1-13.

Finding 3 (Baseline Hypothesis): *There is no difference in the number of* fast-fish, loose-fish, iron holds the whale, *and* deadweight loss *harpoons in the* Sort *and* Right *treatments summed over periods 1-13*.[15]

Evidence: Using a Wilcoxon rank sum test on the 36 independent pairs in the *Sort* treatment and the 18 independent pairs in the *Right* treatment, we fail to reject the null hypothesis of equal number of harpoons in each of the three categories with two-sided tests (*fast-fish, loose-fish*:

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[15] To illustrate that the participants are in fact exploring different rules early in the session and weighing the costs and benefits of the colored lines, the following is a conversation of one pair in periods 3 and 4 of *Sort*5:

> Orchid: use the colored ones... then we know who's is whos
> Orchid: white are up for grabs
> Olive: hm
> Olive: We can see who is hitting whose just by the lines
> Olive: don't need the colored
> Orchid: can we agree that if it's my color you wont go for it? that justifies the higher cost for the colored line
> Orchid: we're not always next to eachother

*Civil*4 has a similar conversation in period 19:

> Green:ok so when its not ur color dont grab itt
> Brown: haha
> Brown: and if you see the word 'hit dont go after it"
> Green: yeah
> Brown: you guys are balla..using colored lines

(For those readers unfamiliar with urban vernacular, "balla" is a suburban variant of "baller", which means a person ostentatiously displaying wealth and a cocky attitude.)

We also conducted a rigorous content analysis on the chat transcripts involving 200 hours of work by seven research assistants. Appendix B discusses the procedures and results. Of the 21 different codes that the research assistants could assign to each line of chat, there was only one significant treatment difference: *Civil* sextuplets discuss the change in circle movements more than the *Rude* sextuplets. One out of 21 is too close to $\alpha = .05$ to draw any conclusions.

$U_{36,18}$ = 393.5, p-value = 0.2047; *iron holds the whale*: $U_{36,18}$ = 367, p-value = 0.4387;[16] and *deadweight loss*: $U_{36,18}$ = 334.5, p-value = 0.8495).

Having established that we have the same baseline in *Sort* and *Right* for the first 13 periods, we check that our metric separates out civil-minded pairs in *Sort* relative to *Right* where both civil and rude subjects are "lumped" together.

Finding 4 (Civil Pair Hypothesis): Civil *pairs throw fewer* deadweight loss *harpoons than* Right *pairs for periods 8-13.*

Evidence: Using a Wilcoxon rank sum test on the 18 independent *Civil* pairs and the 18 independent *Right* pairs, we reject the null hypothesis of equal number of *deadweight loss* harpoons in favor of the alternative of fewer *deadweight loss* harpoons in *Civil* ($U_{18,18}$ = 240, p-value = 0.0066, one-sided test). On average a *Civil* pair throws 1.1 *deadweight loss* harpoons as opposed to 3.8 such harpoons for the average *Right* pair.

Finding 4 is only useful if it serves as the predictor for wealth-maximizing, rule-following behavior among *Civil* sextuplets, which is our next finding.

Finding 5 (Civil Sextuplet Hypothesis): Civil *sextuplets throw fewer* deadweight loss *harpoons than* Right *and* Rude *sextuplets for periods 21-26.*

Evidence: Using a Wilcoxon rank sum test, we reject the null hypothesis of an equal number of *deadweight loss* harpoons in favor of the alternative of fewer *deadweight loss* harpoons in *Civil* than in *Right* ($U_{6,6}$ = 29, p-value = 0.0465, one-sided test) and in *Rude* ($U_{6,6}$ = 27.5, p-value = 0.0660, one-sided test). On average, a *Civil* sextuplet throws 9.3 *deadweight loss* harpoons per session over the last 6 periods with right whales, whereas *Right* and *Rude* sextuplets each throw 29.3 such harpoons over the same time period.[17]

Finding 1b reports no significant difference in the number of *fast-fish, loose-fish* and *iron holds the whale* harpoon throws in the *Right* treatment. But as Figure 4 suggests, *Right* sessions are either wealth-maximizing or they are not. *Right* whalers who are not wealth-maximizing

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[16] In the sole exception to footnote 12, for periods 8-13 we can reject the null hypothesis in favor the alternative that there are more *iron holds the whale* harpoons in the *Right* treatment than in the *Sort* treatment ($U_{36,18}$ = 424.5, p-value = 0.0648).

[17] Yes, the total number of *deadweight loss* harpoons is exactly the same in *Right* and *Rude* over these six periods. This observation together with Finding 5 suggests the strong degree to which a few bad apples can spoil the whole barrel and confirms that our choice of six subjects per sessions is successful in generating anarchy.

may throw costly *iron holds the whale* harpoons, but what about *Civil* whalers who we know from Finding 5 *are* wealth-maximizing? Naturally, we ask whether *Civil* whalers in the *Sort* treatment throw more *fast-fish, loose-fish* than *iron holds the whale* harpoons at right whales. Our next result strongly finds this to be the case.

Finding 6 (Civil Fast-Fish, Loose-Fish Hypothesis): *With right whale prey* Civil *sextuplets throw more* fast-fish, loose-fish *than* iron holds the whale *harpoons*.

Evidence: Using a Wilcoxon signed rank test, we reject the null hypothesis of equal number of *fast-fish, loose-fish* and *iron holds the whale* harpoons in favor of the alternative of more *fast-fish, loose-fish* harpoons in *Civil* (W_6 = 20, *p*-value = 0.0312, one-sided). Of all the non-*deadweight loss* harpoons that are thrown for periods 21-26, the *Civil* sessions respectively throw *fast-fish, loose-fish* harpoons 84.5%, 82.4%, 33.8%, 81.3%, 88.2%, and 94.4% of the time.

Taken together, Findings 1b and 6 support Ellickson's (our *Ex Ante*) hypothesis on the adoption of wealth-maximizing norms and highlight the importance of group selection. Although we did not initially recognize the importance of Ellickson's implicit assumption that whalers were survivors of an evolutionary process that weeded out inefficient "whalers", our laboratory experiment demonstrates that some groups of individuals may be, at least as a group, simply ill-suited to hunt whales. If the subjects in the three inefficient *Right* sessions had been actual 18th or 19th century whalers, their "rude" behavior would have put them out of business. Or they would have realized that whaling was for them an inferior means of earning a living, and they would have self-selected into an occupation more suited to their temperament.

Our sorting mechanism unbeknownst to the subjects mimics this process in our laboratory. As in nearly every economic experiment, they have no outside option in the experiment for earning money, nor any enforcement mechanism to minimize deadweight losses except the threat of retaliation (which only causes further deadweight loss). Indeed, a whaling community following *fast-fish, loose-fish* or *iron holds the whale* is unstable under defection or invasion by unruly outsiders. Hence, the importance of cultivating order via the composition of a community. Jaworski and Wilson (2009) illustrate the importance of endogenous group selection for the formation of property rights. In our *Sort* treatment, we draw upon the lessons from Jaworski and Wilson, Ellickson, and our first two treatments by incorporating an endogenous group selection mechanism. Consequently, the results from Finding 6 support our *Ex Ante Hypothesis*.

Having created *Civil* and *Rude* groups via a wealth-maximizing metric, we now examine the responses of these groups to an ecological change in prey and assess the implications of the general wealth-maximizing hypothesis.

Finding 7a (Ellickson Hypothesis): *For* Civil *sextuplets, there is a structural break in the number of* deadweight loss *harpoons thrown when the prey changes from right to sperm whales*.

Evidence: For our quantitative evidence we employ a Chow (1960) test on an OLS regression of the average number of *deadweight loss* harpoons (across the six sessions) on a constant and the period. The results are reported in Table 4. For the *Civil* treatment average as a whole, we reject the null hypothesis of no structural break in period 27 in favor the alternative of a structural break at the 99% level of confidence ($F_{2,22} = 19.20 > F_{2,22}^{.01} = 5.72$). We also conduct this test for each individual session. *Civil*3, -5 and -6 all have statistically significant structural breaks at the 99% and 95% levels of confidence, respectively. The remaining three sessions are insignificant. Figure 6 plots the number of *deadweight loss* harpoons for the treatment as a whole and for the two subsets of sessions that do and do not have structural breaks at the session level. In the top two panels there is a statistically significant <u>negative</u> slope with right whales followed by a statistically significant and <u>positive</u> slope with sperm whales. Notice also that the variance starts low in the early periods of sperm whales, but then increases strikingly toward the end of the sessions. While the three other sessions do not have upward trends with sperm whales, the variance is increasing, which is perhaps an indicator that a (statistically significant) breakdown may be coming later for these sessions (see panel (c) in Figure 6).

The chat transcripts for the final two periods of *Civil*6 exemplify the breakdown in the social order and a yearning for the order of periods past:

Orchid: what happended to the pack olive?
Brown: olive how do you theif?
Pink: why is brown really red
Olive: the rules of the game seemed to have changed, as I noticed from pink
Orchid: how so?
Brown: OUCH
Khaki: yeah i notived that too
Olive: it seems the last person (usually) to touch gets the ball
Brown: i am not commie
Khaki: lol
Olive: well maybe not, I'm not so sure.
Pink: it seems as if i have started an all out war
Orchid: just keep to the old rules
Brown: i think it was better before
Pink: my bad
Olive: okay
Orchid: k
Khaki: yeah i liked it when it was just 2 ppl
Olive: haha
Orchid: true

The wealth-maximizing hypothesis of endogenous rule-governed behavior predicts that the rules of capture for right whales will be ill-suited for sperm whales. Finding 7a supports this hypothesis with *Civil* sextuplets. Finding 7b assesses the implications of the hypothesis for the counterfactual circumstances of counter-sociable groups.

Finding 7b (Ellickson Counterhypothesis): *For five of six of the* Rude *sextuplets, there are no structural breaks in the number of* deadweight loss *harpoons thrown when the prey changes from right to sperm whales.*

Evidence: Table 5 reports the *F*-statistics for a Chow tests by session of an OLS regression of the average number of *deadweight loss* harpoons on a constant and the period. Save *Rude*3, all are highly insignificant. Panel (a) in Figure 7 plots the average number of *deadweight loss* harpoons for these five sessions. There is no structural break in their wealth-maximizing behavior because there is no such behavior to begin with. As their treatment name suggests, they are as Ferguson describes them, "a band of robbers, who prey without restraint, or remorse, on their neighbors" (1767, p. 83). An implicit assumption of the counterhypothesis is that preying without restraint or remorse will not lead to the emergence of wealth-maximizing rules of capture within periods 14-26. *Rude*3 demonstrates that this assumption is not uniformly true. Despite starting period 14 with 12 *deadweight loss* harpoons thrown, that number steadily falls to just one *deadweight loss* harpoon in periods 25 and 26 (see Figure 7). When the prey switches to sperm whales, they remain well-behaved with no *deadweight loss* harpoons for several periods, which is a structural break because they can not improve any more until the end of the session when their number of *deadweight loss* harpoons slightly increases. *Rude*3 is the proverbial exception that proves the rule; it looks more like *Civil*1, -2, and -4 with sperm whales than its treatment counterparts.

Having found striking direct and indirect support for both the wealth-maximizing rule hypothesis and its counterhypothesis, we conclude this section with our final result on the auxiliary hypothesis and auxiliary counterhypothesis.

Finding 8 (Auxiliary Ellickson Hypothesis and Counterhypothesis): *The usage of* IHW *harpoons is constant in* Civil *sextuplets and decreases in* Rude *sextuplets.*

Evidence: We employ a simple OLS regression of average number of *iron holds the whale* harpoons in the *Civil* and *Rude* subtreatments on a constant and the period, for periods 14-39. The results are reported in Table 6. There is no significant trend in the *Civil* regression across the whale types (p-value = 0.1723), and hence the regression explains almost nothing (R^2 = 7.6%). In contrast, the Period covariate is highly significant (p-value < 0.0001) and explains 58.3% of the variance of the dependent variable. Figure 8 plots the average (scaled) number of harpoons thrown in the *Civil* and *Rude* subtreatments, and Figures 9 and 10 the same plots at the session level. While the number of *iron holds the whale* harpoons is increasing in some *Civil* sessions, decreasing in others, and constant in others still, the strength of this finding rests in the *Rude* sextuplets, save for *Rude*1 which looks more like *Civil*1, -2, and -4.

While the usage of *iron holds the whale* harpoons is not increasing in the *Civil* sessions, it is also not decreasing as it is in the *Rude* sessions. This suggests that *Civil* whalers may be on the path to adopting a new wealth-maximizing rule of capture to fit their new ecological environment. The process by which norms of behavior change is undoubtedly long and tedious. Yet the *Civil* whalers, unlike their *Rude* counterparts, appear not to be headed in the wrong direction.

V. Discussion and Conclusion

Over three hundred years before Ellickson, Samuel Pufendorf, a German jurist-philosopher and overlooked precursor of the Enlightenment, was writing on the "Origin of Dominion or Property", in which he defined property as "a Right, by which the very Substance, as it were, of a Thing, so belongs to one Person, that it doth not in whole belong, after the same manner, to any other" (1672; Book IV, Chapter IV). As part of his case for the foundations of property, he describes the antecedent circumstance of "communion", which is

> taken either negatively, or positively. In the former manner things are said to be common, as consider'd before any human Act or Agreement had declared them to be belong to one rather than to another. In the same sense, things thus consider'd are said to be *No Body's*, rather negatively, than privatively, i.e that they are not yet assign'd to any particular Person, not that they are incapable of being so assign'd. They are likewise term'd *res in medio quibusvis exposita*, Things that lie free for any Taker (Book IV, Chapter IV, Section II).

Whales are such things that "lay free to any that would use, and do not belong to one more than another", and moreover, whalers are members of a negative as opposed to a positive community in that no one can be excluded from taking a whale (IV.IV.V). The problem is that even though man is capable of "Kindness by the Furtherance of mutual Good", he is also "often malicious, insolent, and easily provok'd, and as powerful in effecting Mischief, as he is ready in designing it" (II.III.XV).

In this paper we present an experiment that explores Pufendorf's ecological preconditions for property, namely, a negative community without any exogenously enforced rules of capture populated with agonists with a propensity for mischief and petulance, which, as the following representative exclamations attest to, we have replicated in the laboratory: "you're all a bunch of crooks", "o! damn the heathen", "we(')re turning into vultures", "It's a madhouse! A madhouse!", "this is madness", "I'm gonna have nightmares about this tonight", and "This is like lord of the flies, they leave us to fend for ourselves, lol". And so, as Pufendorf explains, "it was left to the Reason of Men to determine what measures should be taken to prevent Discord that might arise amongst them" (IV.IV.III). Likewise we find in our virtual communities, that many, though evidently not all, of our participants desire rules to prevent discord:

*Rude*2, Periods14-15
Green: should we be trying to help each other?
Green: or is selfishness the way to go?
Pink: that's a super good plan
…
Pink: if everyone just agrees to not steal other peoples then we will get more
Blue: that is very true
Green: I think so too
Brown: true
Green: I'm down
Pink: so just do that

*Civil*4, Period14
Brown: hey guys
Green: hey
Brown: if we dont steal from each other
Brown: we make more money
Orange: yeah
Brown: i dont know how you guys feel about that
Brown: we lost 2 full circles
Brown: from competing

But what exactly does the generic rule "don't steal" mean in practice and how does a community come to agree on the rules? Agreement cannot be assumed, for different people may have different ideas of what the rule "don't steal" does and does not mean, as the following conversation in *Civil*4 plainly indicates:

Green: omg teal[18]
Green: u saw i had that one
…
Green: teal
Green: give me half
Green: that was mine
Green: it was green
…

[18] For those unfamiliar with instant messaging shorthand, "omg" means "oh my god!".

> Teal: u lost it so i have to get it
> (Teal does not transfer any money to Green.)

Green is following *iron holds the whale* and expecting at least half of the whale for striking it with a colored harpoon, but *Teal* is following *fast-fish, loose-fish* and will have nothing of it.

Ellickson's hypothesis is that the ecological conditions of the community shape the content of rules so as to maximize wealth, and this shaping process is what this paper examines more deeply with ex ante predictions. "Vulture-like," "greedy" or "selfish" (as undesirable attributes) are defined only with respect to the emergence of rules by consent that are appropriate to the circumstances. We find that simply imposing two different ecological conditions and randomly allocating participants to them is insufficient to observe the two different rules of capture for right and sperm whales that Ellickson postdicts. Another factor is essential, and we might add, all too often taken for granted by economists, viz., that the members of the community are civil-minded *ab initio*.[19] In a civil as opposed to a rude community, no one considers his or her own interest superior to another. Harmony in a civil community is then possible, not by agreement on outcomes, but by agreement on the rules for pursuing one's own interest. By type-casting early actions as civil and rude and sorting people accordingly into *Civil* and *Rude* communities, we observe some two hundred years after the glory days of Anglo-American whaling that civil-minded communities more broadly employ a *fast-fish, loose-fish* rule than their insolent, mischievous counterparts. Moreover, for prey that moves faster and fights harder we find that (a) changing the ecological conditions of a *Civil* community leads to a breakdown in the usefulness of the *fast-fish, loose-fish* rule, and that (b) the factual rule of *iron holds the whale* decreases in usage in our counterfactual *Rude* communities.

Pufendorf brilliantly anticipates by more than three centuries that which Ellickson explains ex post and we explore ex ante on the origins of property:

> in affirming that Men left this [negative] Communion upon the advice and direction of Reason, we pretend not that it was necessary all things should be appropriated in the same Moment; but *according as the Temper or Condition of Men, the Nature of the things themselves, and the difference of Place required*; and as was judg'd most convenient for the cutting off all manner of Quarrel or Dissension (IV.IV.XIII, emphasis added).

The implications for economics and law are far-reaching. For if property evolves in stages through a process circumscribed by the current ecological circumstances of time and place and

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[19] See footnote 12 for what we mean by *civil*.

the particular civil mindset of the people in question, then the history of property is necessarily path dependent. Modern discussions of property tend to focus on the benefits of property rights once they are established, but what Pufendorf clearly articulates about the origins of property and what we too hence *re*discover is the necessary precondition that people are predisposed towards cutting off all manner of quarrel or dissension. Both ecology and civility are mainsprings of property. This paper lays the foundation for endogenously exploring the Pufendorfian steps of moving from resource extraction in a negative community, to resource cultivation in a positive community in which those outside the group are excluded by right from the goods in question, and then finally to a system of private property that further increases the industry of people with the strongest of all incentives—reaping the rewards of one's own efforts.

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Table 1. Summary of Parameters for *Right* and *Sperm* Treatments

Parameter	*Right*	*Sperm*
Probability of successful 1st strike (q)	.75	.25
Probability of successful subsequent strike (θ)	.90	.75
Probability of death after 1st strike (d)	.25	.10
Probability of death after subsequent strike (δ)	.50	.25
Expected number of harpoons (h) to pull in a whale*	≈1.2697	≈1.9577
Whale Speed	50 pixels/sec	75 pixels/sec
Whale Speed reduction after 1st strike	.75	.75
Whale Speed reduction after 2nd strike	.50	.50
Whaler Speed	25 pixels/sec	25 pixels/sec
Value of whole whale	100¢	100¢
Portion allocated to m successful whalers	$1/m^2$	$1/m^2$
Cost of regular harpoon	10¢	10¢
Cost of colored harpoon	20¢	20¢
Diameter of harpoon range	175 pixels	175 pixels
Diameter of sight	325 pixels	325 pixels
Number of whales per pair (periods 1-13)	4	4
Number of whales per sextuplet (periods 14-26)	10	10
Cash endowment (to buy harpoons for period 1)	150¢	150¢
Length of Gathering (Phase A)	90 seconds	90 seconds
Length of Interim (Phase B)	90 seconds	90 seconds
Time to pull in	5 seconds	5 seconds
Time to cool down	5 seconds	5 seconds

$$*E(h) = 1\cdot q + 2\cdot[d(1-q) + (1-q)(1-d)\theta]$$

$$+ (1-q)(1-d)(1-\theta)\sum_{n=3}^{\infty} n[\delta(1-\delta)^{n-3}(1-\theta)^{n-3} + (1-\delta)^{n-2}(1-\theta)^{n-3}\theta]$$

Table 2. Transfers of Whales and Cash by Session for Periods 14-26

	Right treatment			*Sperm* treatment	
	Total Revenue	$\sum_{t=14}^{26} w_t + c_t$		*Total Revenue*	$\sum_{t=14}^{26} w_t + c_t$
*Right*1	10,364¢	463¢	*Sperm*1	11,316¢	1,061¢
*Right*2	10,772¢	0¢	*Sperm*2	9,631¢	2¢
*Right*3	12,133¢	0¢	*Sperm*3	10,723¢	0¢
*Right*4	12,133¢	0¢	*Sperm*4	10,205¢	562¢
*Right*5	10,670¢	38¢	*Sperm*5	9,748¢	0¢
*Right*6	9,239¢	0¢	*Sperm*6	10,040¢	2,770¢
Average	10,885¢	83.5¢	Average	10,277¢	732.5¢

Table 3. Summary of Parameters for *Right* and *Sort* Treatments

Parameter	*Right* Periods 1-26	*Sort* (Right whales) Periods 1-26	*Sort* (Sperm whales) Periods 27-39
Probability of successful 1st strike	.75	.75	.25
Probability of successful subsequent strike	.90	.90	.75
Probability of death after 1st strike	.25	.25	.10
Probability of death after subsequent strike	.50	.50	.25
Expected number of harpoons to pull in a whale	≈1.2697	≈1.2697	≈1.9577
Whale Speed	50 pixels/sec	50 pixels/sec	75 pixels/sec
Whale Speed reduction after 1st strike	.75	.75	.75
Whale Speed reduction after 2nd strike	.50	.50	.50
Whaler Speed	25 pixels/sec	25 pixels/sec	25 pixels/sec
Value of whole whale	100¢	60¢	60¢
Portion allocated to *m* successful whalers	$1/m^2$	$1/m^2$	$1/m^2$
Cost of regular harpoon	10¢	6¢	6¢
Cost of colored harpoon	20¢	12¢	12¢
Diameter of harpoon range	175 pixels	175 pixels	175 pixels
Diameter of sight	325 pixels	325 pixels	325 pixels
Number of whales per pair (periods 1-13)	4	4	NA
Number of whales per sextuplet	10	10	10
Cash endowment (to buy harpoons for period 1)	150¢	90¢	NA
Length of Gathering (Phase A)	90 seconds	90 seconds	90 seconds
Length of Interim (Phase B)	90 seconds	60 seconds	60 seconds
Time to pull in	5 seconds	5 seconds	5 seconds
Time to cool down	5 seconds	5 seconds	5 seconds

Table 4. Estimated Linear Regressions for *Civil Deadweight Loss* Harpoons

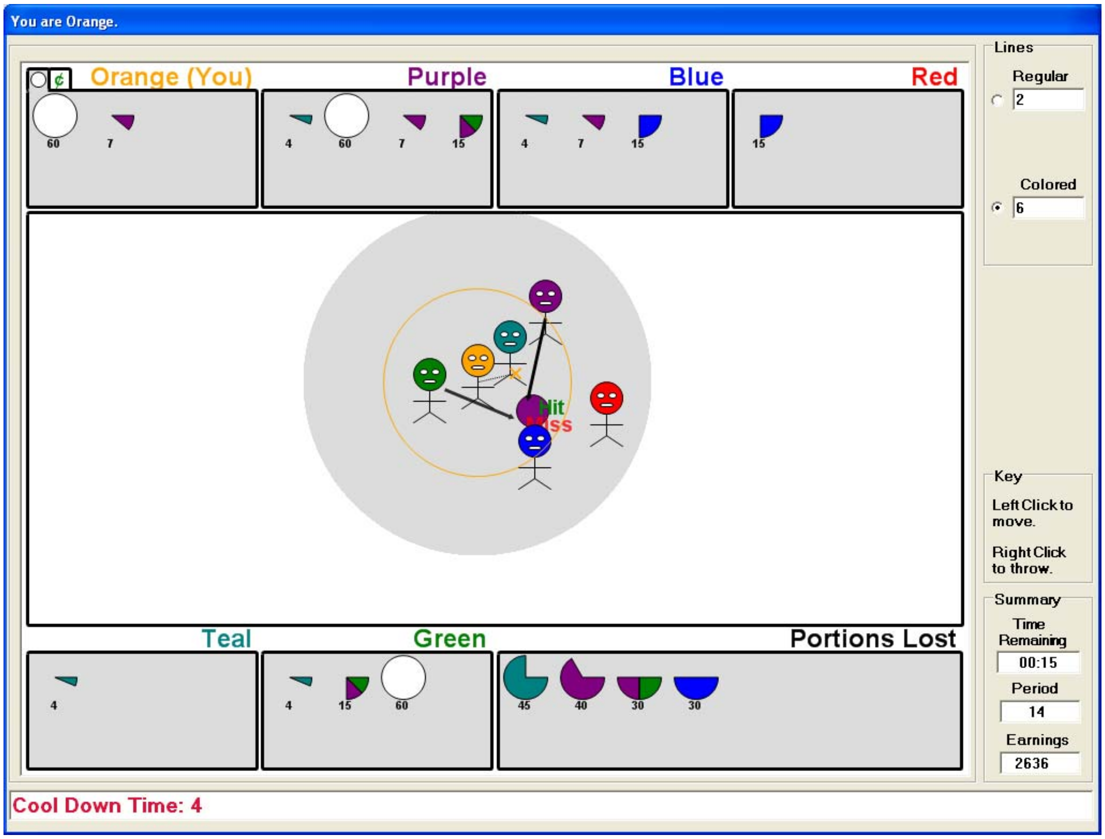
Coefficient	Periods 14-39	*p*-value	Periods 14-26	*p*-value	Periods 26-39	*p*-value
Civil (all)						
Constant	20.36	<0.0001	44.16	<0.0001	-16.16	0.0287
Period	-0.33	0.0334	-1.53	0.0006	0.78	0.0020
$\boldsymbol{F_{2,22}}$	**19.20**					
*Civil*1						
Constant	2.45	0.0090	4.77	0.0575	0.81	0.6783
Period	-0.03	0.2873	-0.15	0.1915	0.02	0.7611
$F_{2,22}$	1.15					
*Civil*2						
Constant	0.86	0.3437	1.04	0.5598	-3.63	0.2766
Period	0.05	0.1646	0.04	0.6166	0.18	0.0892
$F_{2,22}$	1.23					
*Civil*3						
Constant	6.10	0.0042	16.18	0.0043	-3.22	0.1721
Period	-0.15	0.0374	-0.67	0.0116	0.14	0.0662
$\boldsymbol{F_{2,22}}$	**6.69**					
*Civil*4						
Constant	2.61	0.0240	5.89	0.0478	5.18	0.0670
Period	-0.05	0.2360	-0.23	0.1111	-0.12	0.1536
$F_{2,22}$	2.01					
*Civil*5						
Constant	9.86	0.0000	16.69	0.0016	-2.83	0.1695
Period	-0.28	0.0002	-0.62	0.0098	0.11	0.0921
$\boldsymbol{F_{2,22}}$	**6.18**					
*Civil*6						
Constant	-1.52	0.2435	-0.41	0.8575	-12.46	0.0102
Period	0.13	0.0078	0.09	0.4084	0.46	0.0031
$\boldsymbol{F_{2,22}}$	**4.48**					

Table 5. Chow Test Statistics for *Deadweight Loss* Harpoons by *Rude* Session

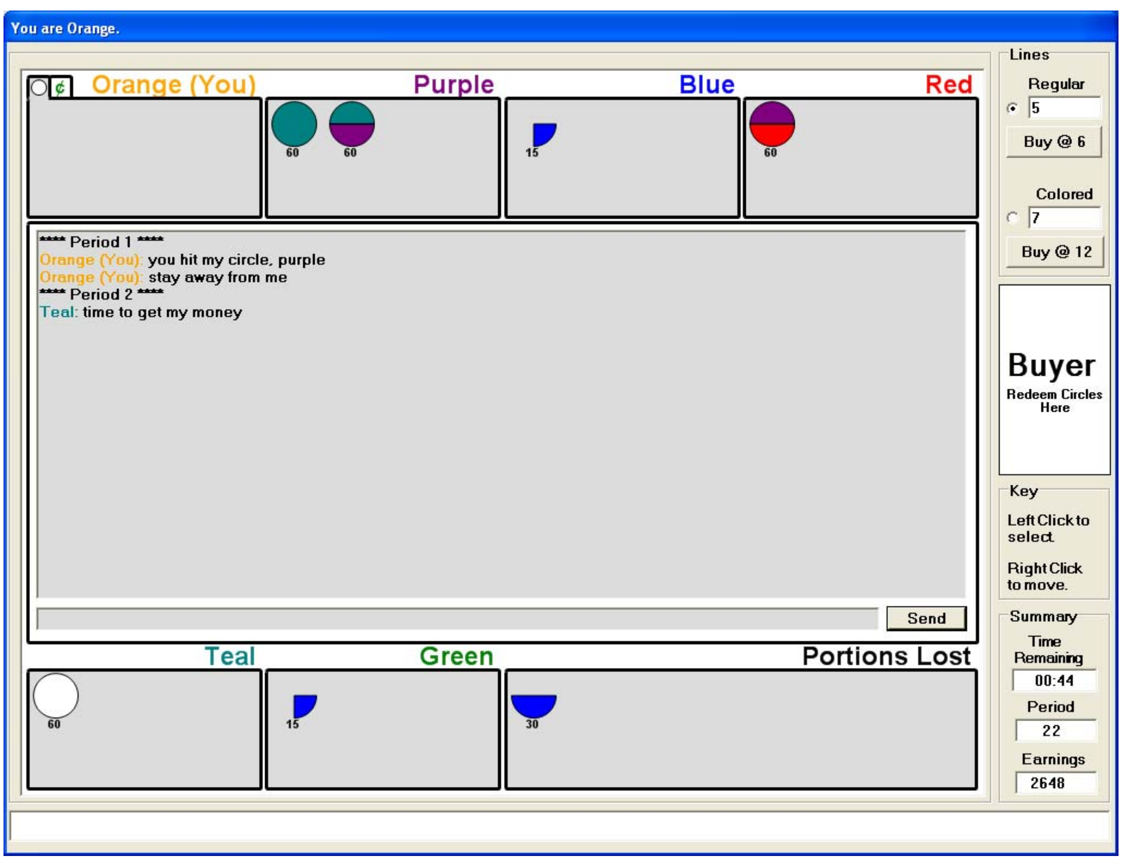
	$F_{2,22}$
*Rude*1	1.78
*Rude*2	1.53
*Rude*3	17.29
*Rude*4	1.46
*Rude*5	1.80
*Rude*6	1.60
$F_{2,22}^{.05}$	3.44

Table 6. Estimated Linear Regressions for *Iron Holds the Whale* Harpoons for Periods 14-39

	Civil		*Rude*	
Coefficient	Estimate	*p*-value	Estimate	*p*-value
Constant	4.33	<0.0001	4.98	<0.0001
Period	-0.03	0.1723	-0.08	<0.0001
R^2	7.6%		58.3%	
Obs.	26		26	



Panel (a). Gathering Phase



Panel (b). Interim Phase

Figure 1. Screenshots for the Gathering and Interim Phases

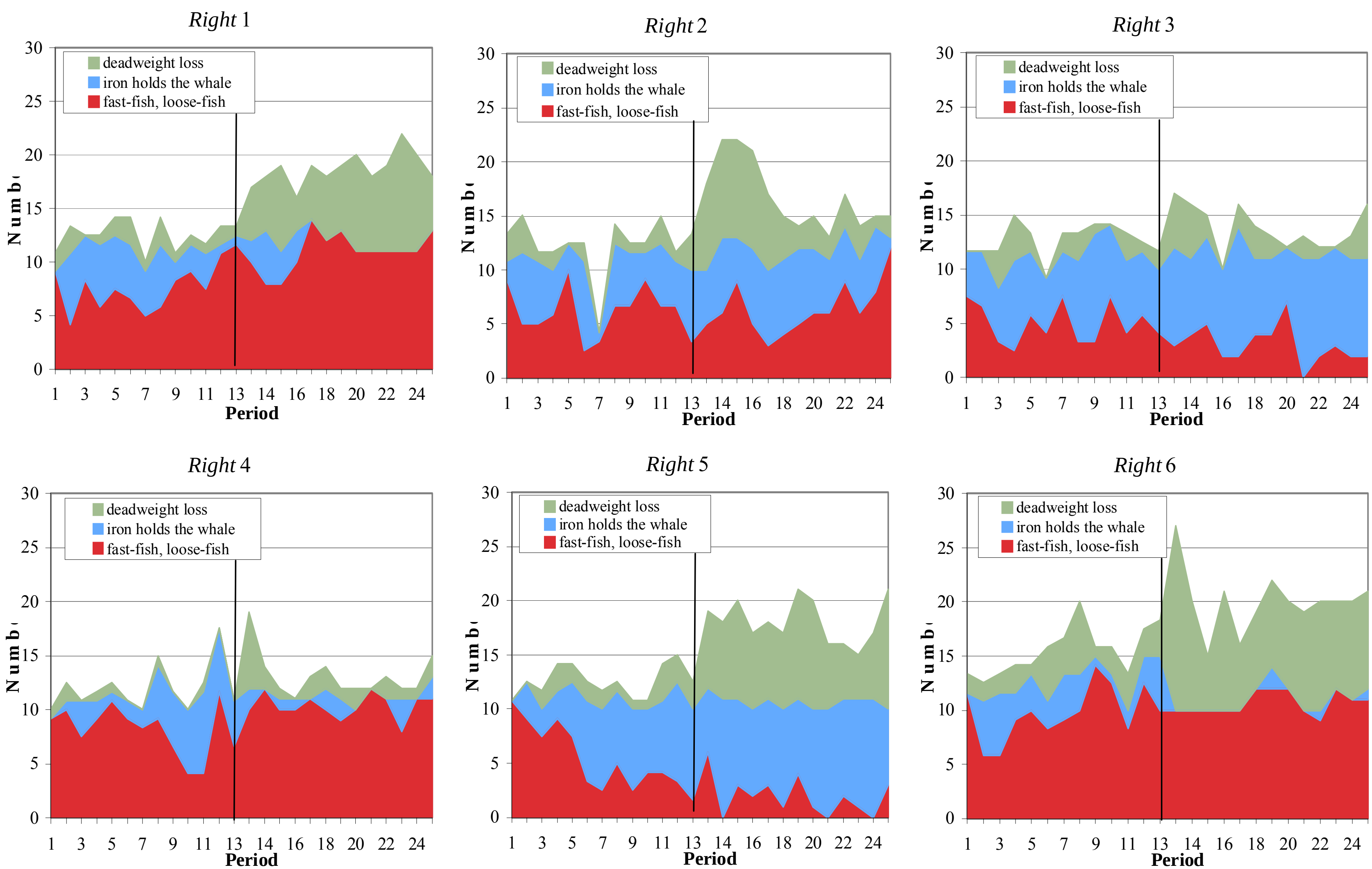


Figure 2. Stacked Area Plot of Harpoon Types by Session for the *Right* Treatment

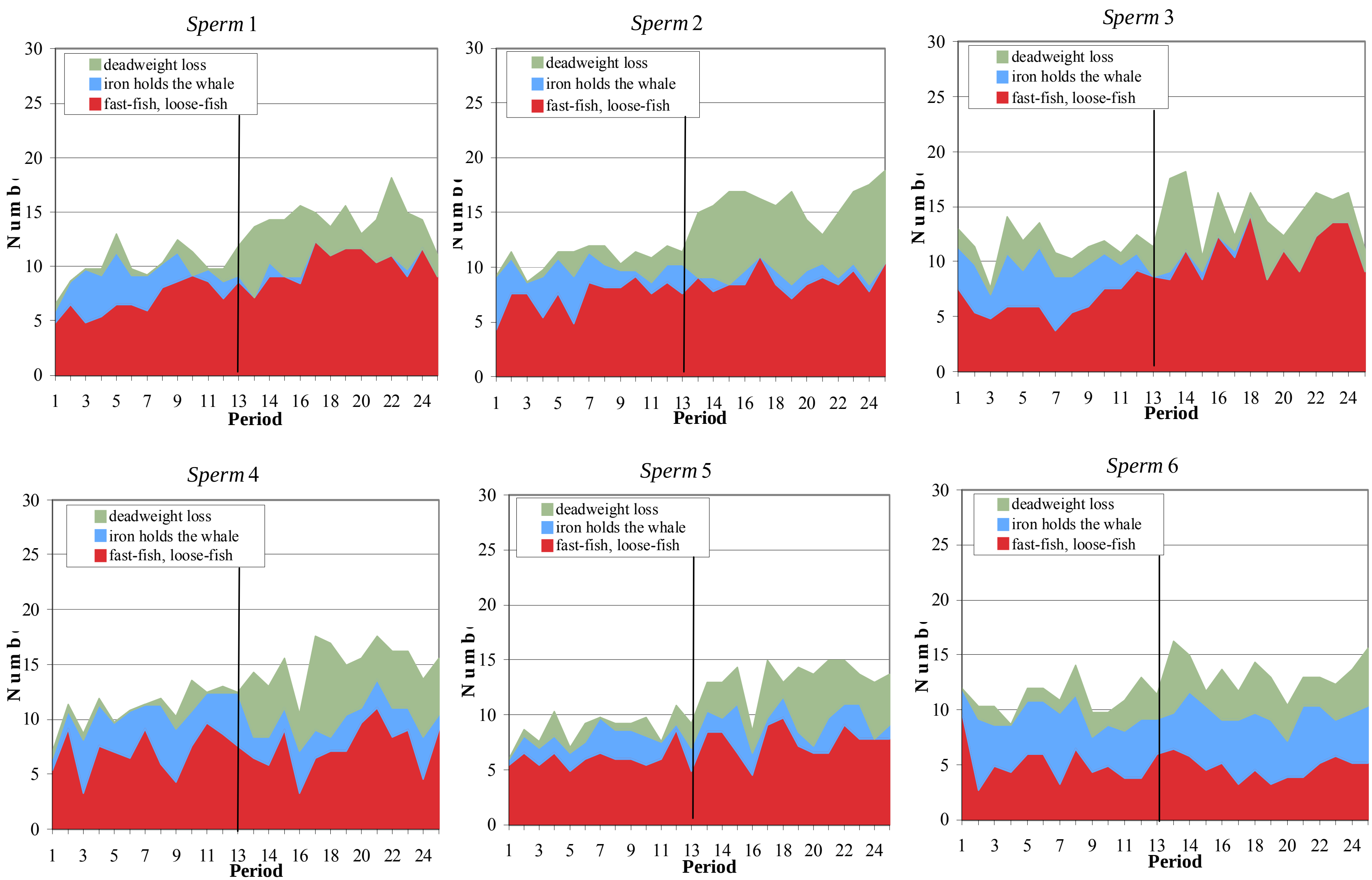


Figure 3. Stacked Area Plot of Harpoon Types by Session for the *Sperm* Treatment

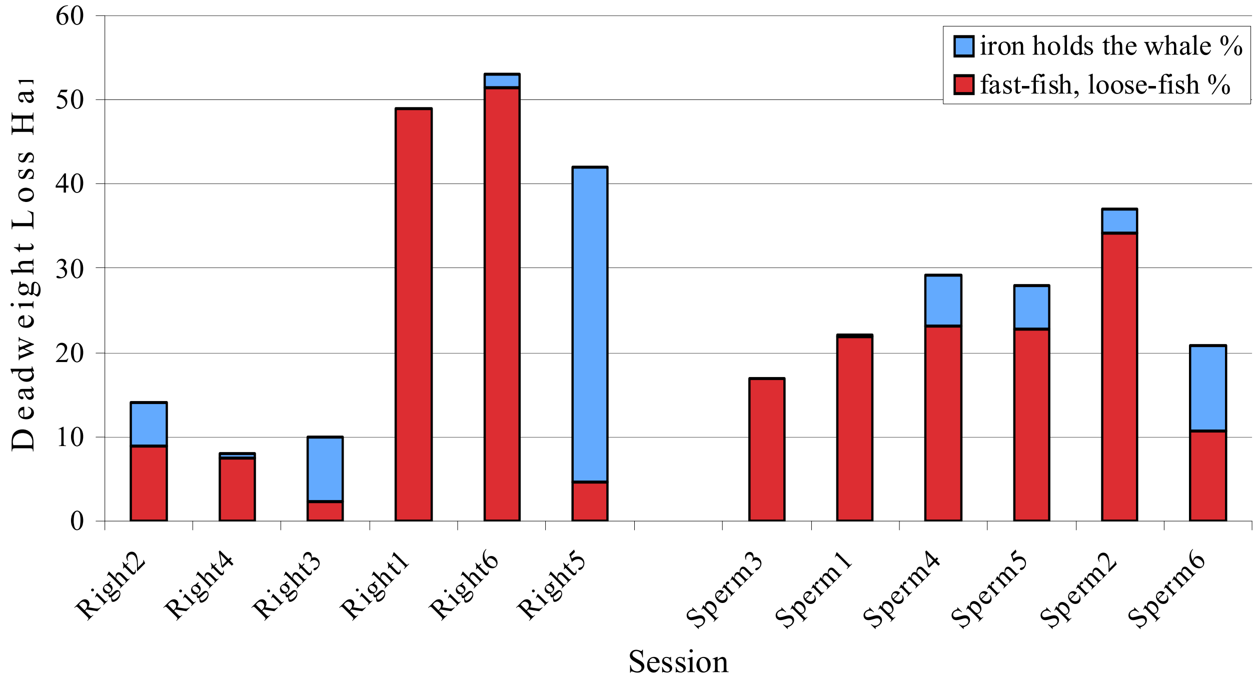


Figure 4. Summary of *Right* and *Sperm* Treatments

Note: The total height of the bar is the number of deadweight loss harpoons thrown over periods 21-26, and the red and blue areas report the relative percentage of non-deadweight loss harpoons for periods 21-26.

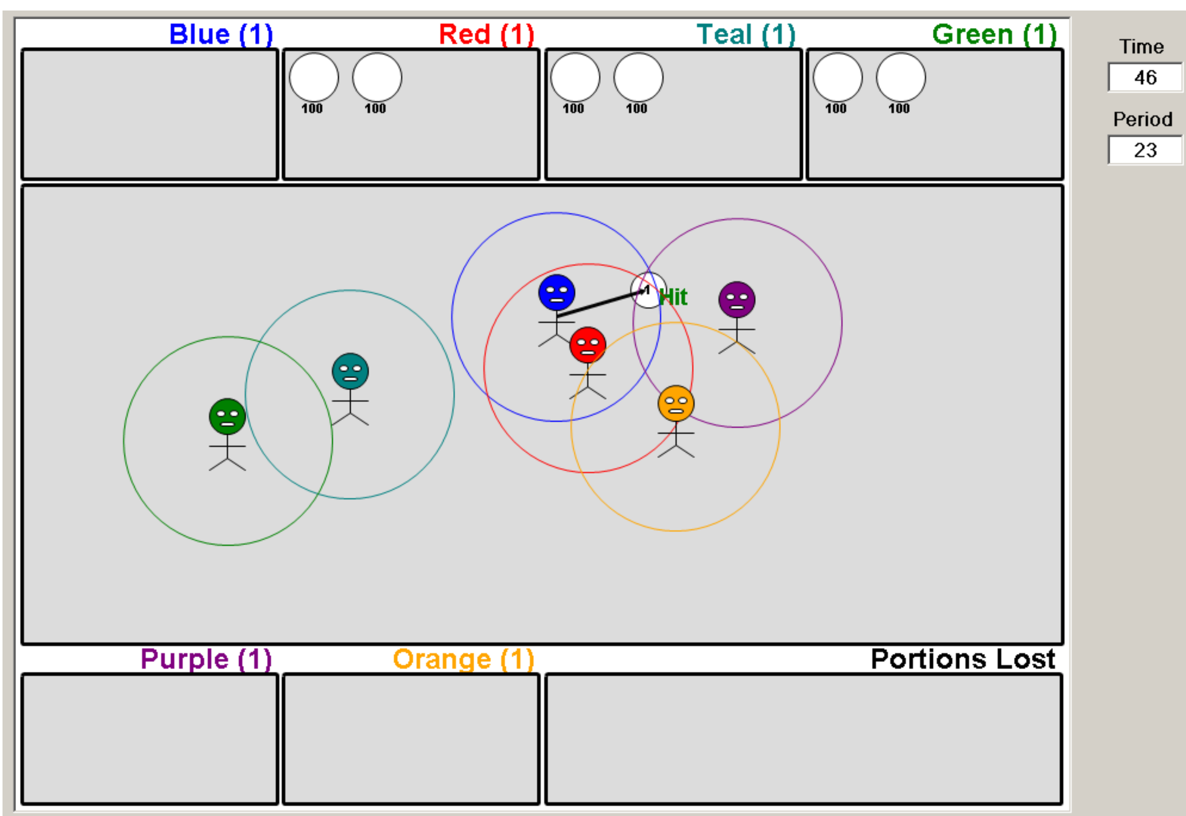
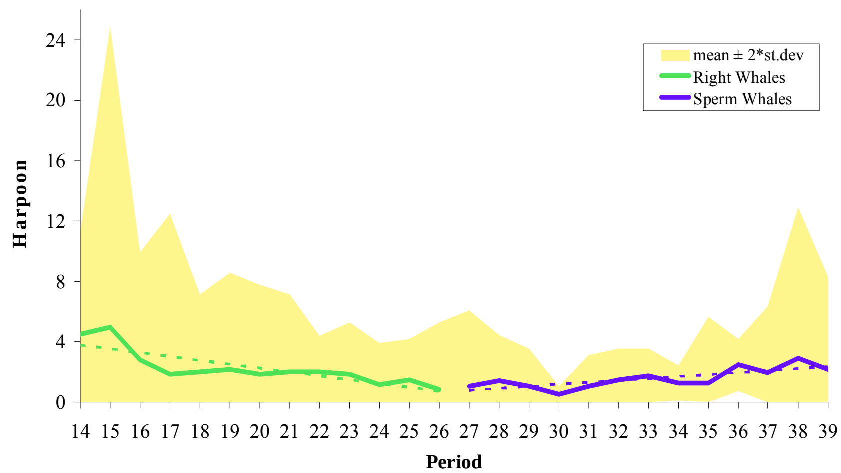
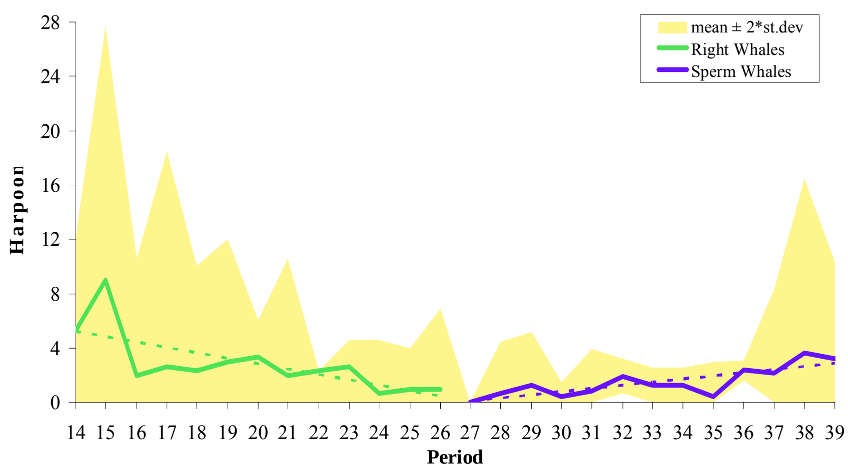


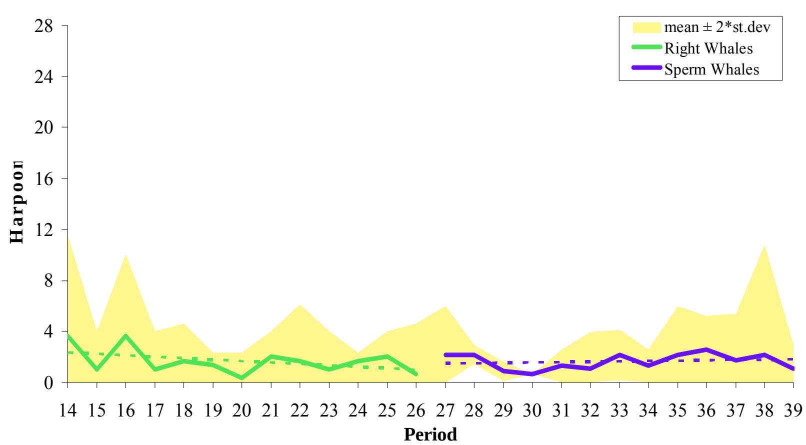
Figure 5. Snapshot of *Fast-fish, Loose-fish* at Work in *Right*4



Panel (a). Average of All Sessions



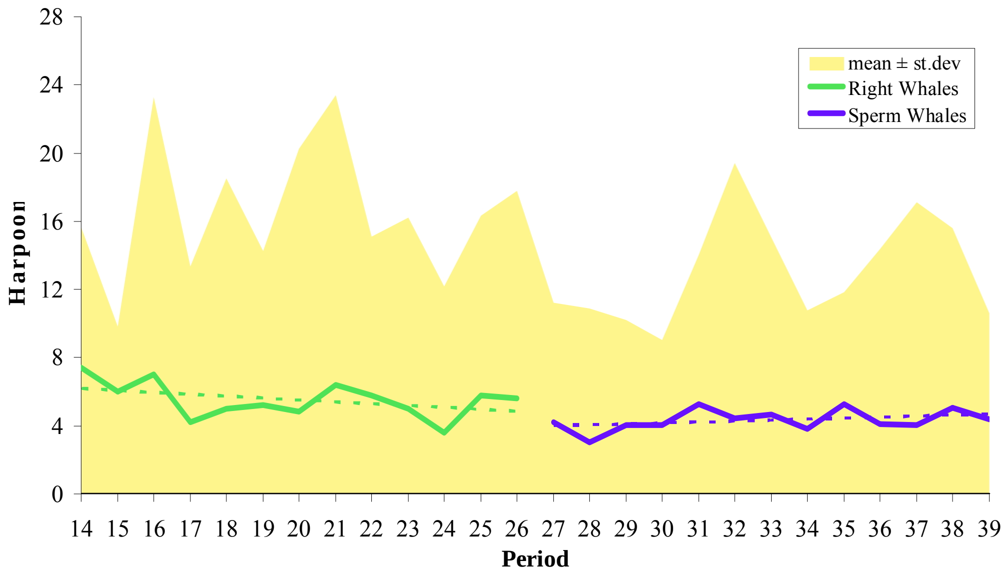
*Panel (b). Average of Civil*3,5,6



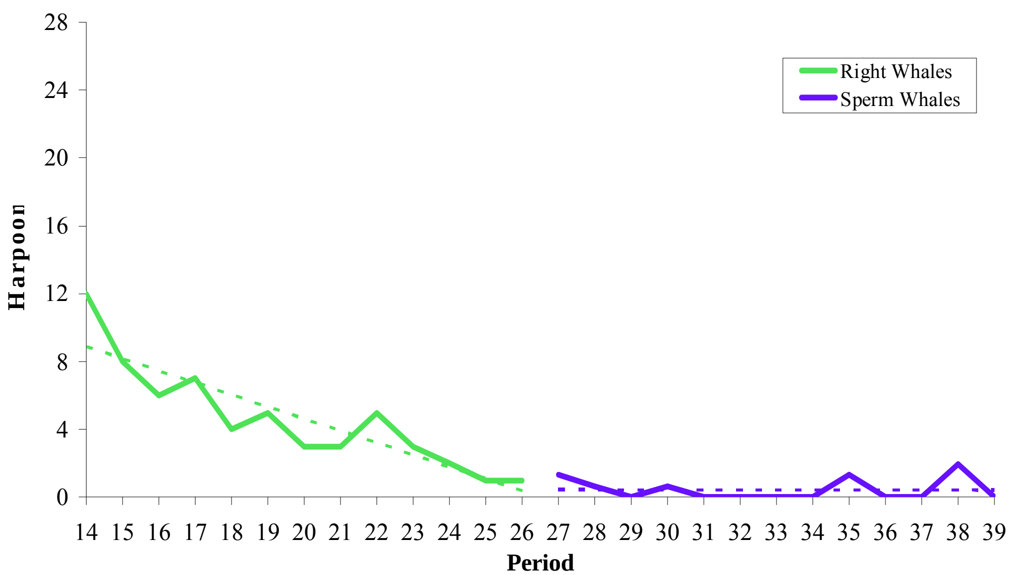
*Panel (c). Average of Civil*1,2,4

Figure 6. *Civil Deadweight Loss* Harpoons

Note: The portion of $\mu - 2\sigma$ that falls below zero is added to $\mu + 2\sigma$.



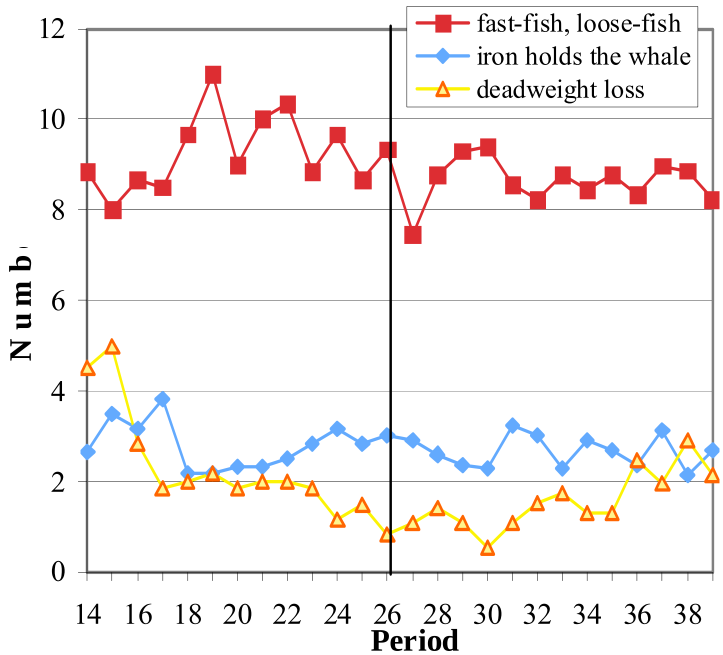
*Panel (a). Average of Rude*1,2,4,5,6



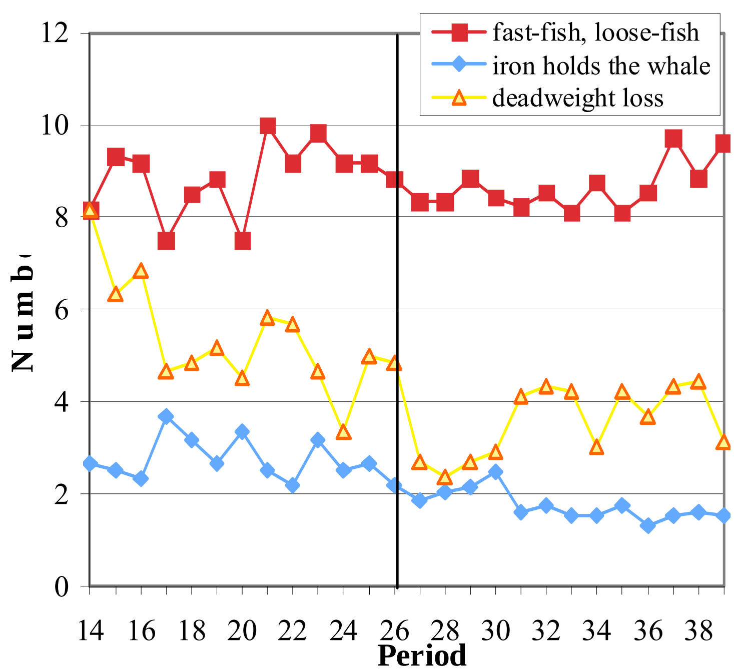
*Panel (b). Rude*3

Figure 7. *Rude Deadweight Loss* Harpoons

Note: The portion of $\mu - 2\sigma$ that falls below zero is added to $\mu + 2\sigma$.



Panel (a). ***Civil*** **Sextuplets**



Panel (b). ***Rude*** **Sextuplets**

Figure 8. Average Number of Harpoons by Type for the *Sort* Sextuplets

Not for publication

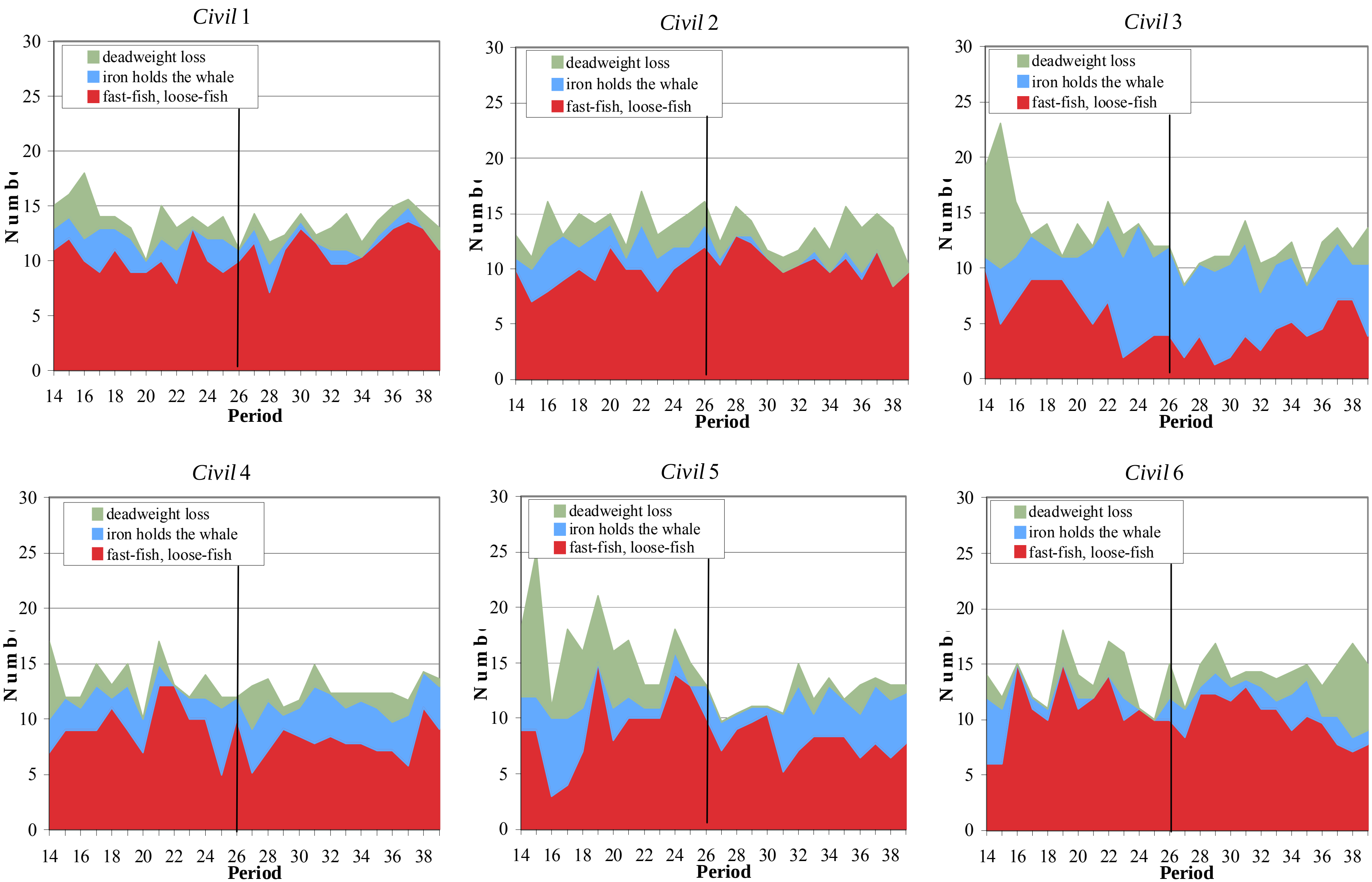


Figure 9. Stacked Area Plot of Harpoon Types by Session for the *Civil* Sextuplets

Not for publication

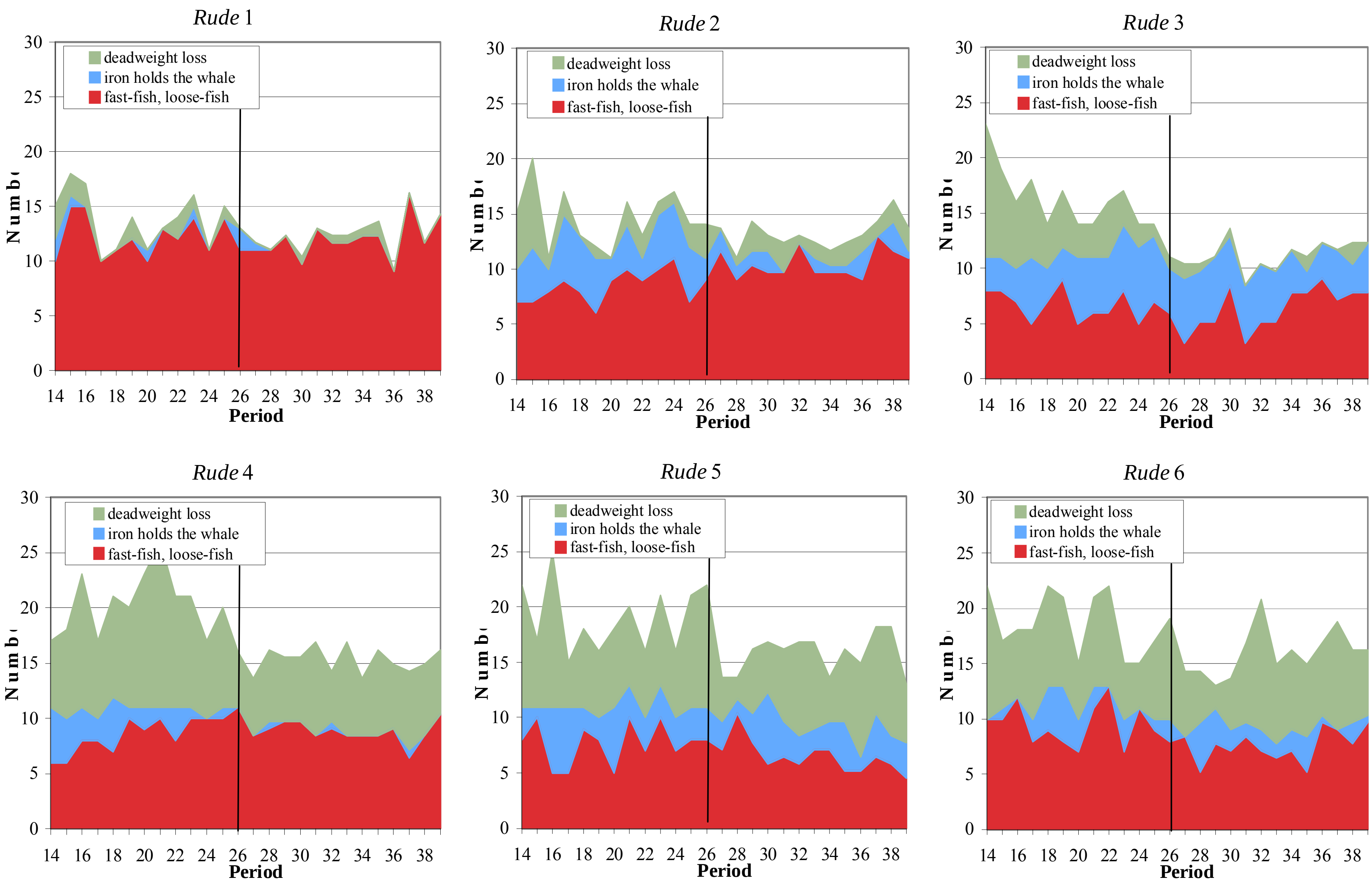


Figure 10. Stacked Area Plot of Harpoon Types by Session for the *Rude* Sextuplets

Appendix A. Experiment Instructions (Not for publication)

<Page 1>

Welcome

You will be participating in an economics experiment. The choices you make while in this experiment can earn you money, which will be paid to you in cash at the conclusion of the experiment.

In this experiment, you will be a **Red/Blue/Green/Teal/Orange/Purple** person. You and 5 other people will be gathering circles over the course of several periods. Each period consists of two phases: the gathering phase and the interim phase.

<Page 2>

Gathering Phase

During the **90**-second gathering phase, the middle of the screen will display a gathering area, where each person is represented by a stick figure. Circles will randomly appear and move around this area. To move your stick figure around, **left click** anywhere in the gathering area and your figure will move to that spot. Do this now.

To gather circles, you must throw out a line from your stick figure to a moving circle. To do this, **right click** anywhere in the gathering area. If you **right click** on a circle, your figure will throw a line to that circle and attempt to catch it. You cannot throw out a line beyond the colored circle surrounding you stick figure. (You cannot do this until the experiment begins.)

<Page 3>

Gathering Phase (continued)

After successfully striking a circle with a line, it will take 5 seconds for you to attempt to catch it. The computer will determine randomly whether you were successful in catching the circle. If you are successful, it will appear in your cargo area located around the border of the gathering area. The cargo boxes of the other people in the experiment also displayed here.

After you use a line, you will have to wait 5 seconds before you can throw another one. During this time you will still be able to move around but you will be unable to throw lines.

<Page 4>

Gathering Phase (continued)

The Status Bar along the bottom of the screen will keep you updated with the events of the gathering phase.

On the top right side, you will see the number of lines that you have left. There are two types of lines, *regular* and *colored* which can be selected by using the appropriate radio button next to them. Both lines work in the same way with one exception. If you hit a circle with a *colored* line, the circle will turn your color whether or not the computer determines you are successful in catching it.

<Page 5>

Gathering Phase (continued)

More than one person may attempt to catch a circle at the same time. If more than one person is successful in catching a circle, each successful person will receive only fraction of the circle, where the sum of the individual fractions is less than the whole circle. Each person receives $1/n^2$, where n is the number of people successful in catching the circle. The remaining portions of a circle that no one receives are displayed in the 'Portions Lost' area at the bottom of the screen.

The value of a circle is displayed under the circle in the cargo area. All whole circles will have a starting value of **100¢**.

If your line hits a circle, but you are not successful in catching it, the circle will move away from you, but at a slower pace. Others can attempt to catch the circle as it moves away from you.

<Page 6>

Interim Phase

Between gathering phases is a **90-**second an interim phase. During the interim phase you are free to talk with the other people in the experiment. Type your message in the bottom of the chat area, and then press ENTER or click the SEND button. (You cannot do this until the experiment begins.)

You are free to discuss any and all aspects of the experiment, with the following exceptions: you may not reveal your name, discuss side payments, make threats, or engage in inappropriate language (including such shorthand as 'WTF'). If you do, you will be excused and you will forfeit your earnings.

<Page 7>

Interim Phase (continued)

To convert your gathered circles into earnings you must move them to the Buyer on the right side of the screen. Your cumulative earnings are displayed in the lower right.

To move a circle, first **Left click** to select a circle (it will become highlighted in yellow). Then with the **Right mouse button depressed**, drag the circle to move it. Do this now. If you have a question, please raise your hand.

If you move a circle to another person's cargo area, the circle will be transferred to them. (You cannot do this until the experiment begins.)

At the end each interim phase any circles remaining in the cargo box will disappear.

<Page 8>

Interim Phase (continued)

Money can also be moved in the same way as circles. First click on the **¢** tab in your cargo area and then left click on the desired amounts to add them to your selected total. Then right click and drag your selected total to another cargo area. That money will be transferred from you to the other player.

You may also purchase additional lines by clicking on the BUY button next to the type of line you would like to purchase. The cost of the lines is taken out of your earnings. You will be given an initial allotment of lines. After that you will be able to purchase *colored* lines for 20¢ and *regular* lines for 10¢.

Buy 5 *colored* and 5 *regular* lines now. If you have a question, please raise your hand.

<Page 9>

This is the end of the instructions. If you have any questions or if you have not purchase any lines or if you have not redeemed a circle, please raise your hand and a monitor will come by.

If you are finished with the instructions please press Start. The instructions will remain on your screen until the experiment starts.

Appendix B. Content Analysis Procedures and Results (Not for publication)

In this appendix we examine the chat room transcripts from the Interim phase. Actions may speak louder than words, but this analysis—though noisy—provides a richer picture of the subjects' mindsets and behavior than harpoon categorizing. In particular, it reveals that subjects are concerned with deadweight loss, highlights the behavioral norms they adopt, and also importantly those they do not adopt.

Following Cooper and Kagel's (2005) procedure for analyzing dialogue from entry limit pricing games, we surveyed chat transcripts and developed separate sets of codes that were then reconciled to the single list presented in Table B1. Several of the codes reference norms identified by Ellickson (1987). In some cases minor changes to the content of these norms were dictated by the specifics of our experimental environment.

Seven undergraduate research assistants unfamiliar with the objectives of the research project were trained to code the chat room transcripts after participating in an abbreviated session with each other and without payment.[20] If an individual line of chat corresponded to a particular code, they tagged it once with that code. If a single line of chat corresponded to several different codes it was tagged multiple times with the relevant codes. The decision to code individual lines of chat rather than multiple line dialogues was made to avoid a problem identified in Cooper and Kagel, namely, in which experimental period should a dialogue extending over several such periods be recorded? In another departure from Cooper and Kagel, the codings of separate research assistants were not averaged or correlated. Rather, the coders were split into three initial groups: two pairs and one group of three. Each group coded all eighteen sessions. Then, as one group of seven, they went back through each session and reached a line-by-line consensus. It is this consensus that we report in Figure B1 below.

[20] The document used to train coders is available upon request.

Table B1. Chat Code Descriptions

Code	Description
	Subject (mentions/has/is)…
1	Aware of/concerned about deadweight loss
2	Aware of/concerned about complicated/costly norms
3*	Norm: Possession-decides
4*	Norm: Fresh pursuit
5*	Norm: Reasonable prospect
6*	Norm: Fast-fish, loose-fish
7*	Norm: Iron holds the whale
8*	Norm: Split ownership (e.g. 50/50)
9	Norm: Spatial (e.g. territories, zones, split screen)
10[a]	Norm: Everyone for him/herself
11	Norm: Turn taking
12	Norm: Non-specific teamwork
13	Norm: Other
14	Belief: colored lines useless
15	Belief: colored lines serve purpose
16	Reports or promotes cooperation
17	Disapproves of another subject's action
18	Disapproves of another subject's action (names names)
19	Reports norm violation
20	Apology for an accidental click
21[b]	Correctly surmises a change in circle movement

* From Ellickson (1989)
[a] Explicit norm as opposed to all-for-all behavior in the absence of any norm
[b] Only applies to periods 27-39 of the *Sort* sessions

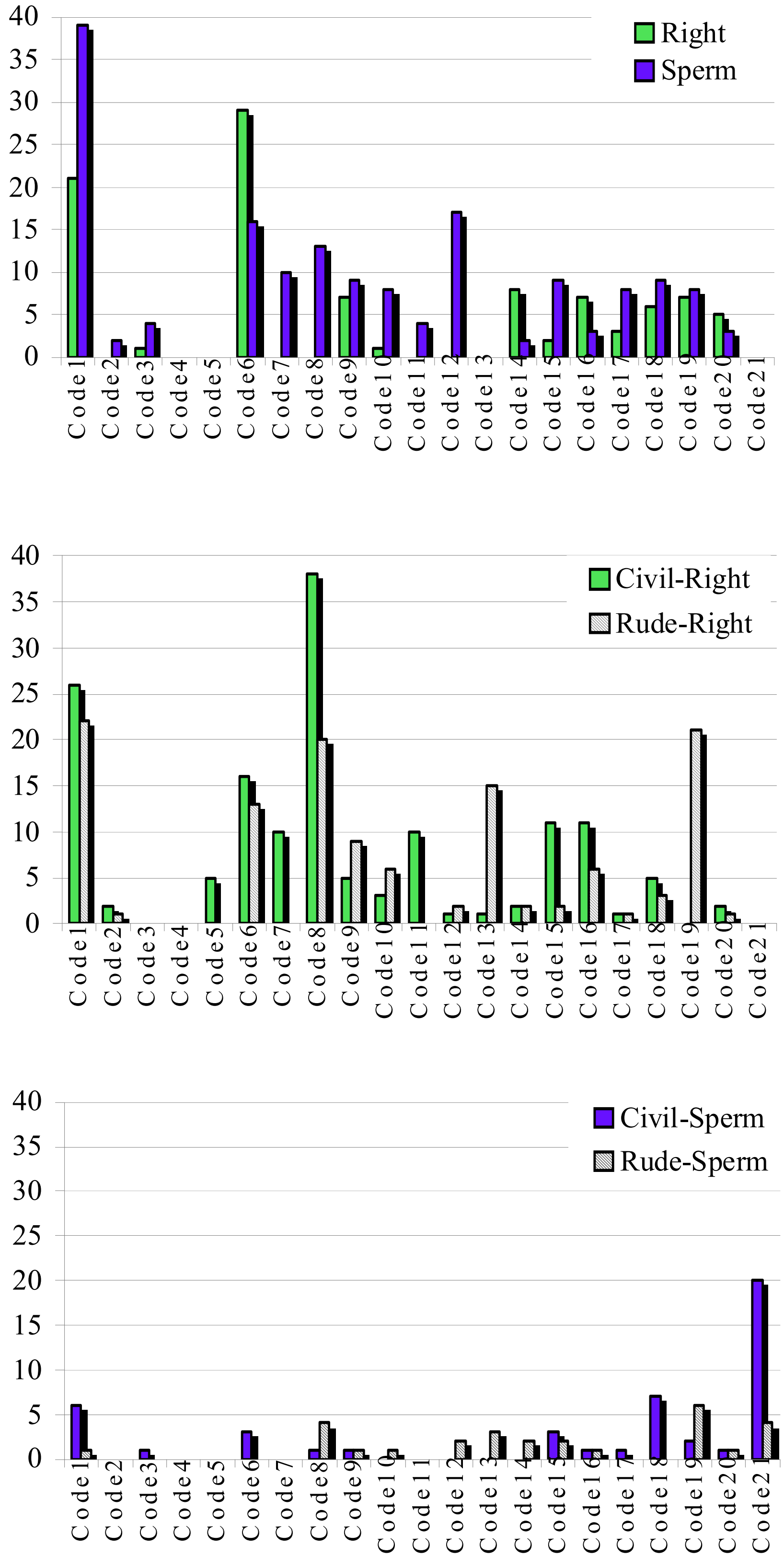


Figure B1. Results of Content Analysis by Treatment