THE COMMONS DILEMMA: A
QUANTITATIVE REVIEW

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THE COMMONS DILEMMA: A Quantitative Review

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ABSTRACT

Commons dilemmas involve a conflict between individual and group interests with respect to the management of limited shared resources. Many of the most serious problems facing mankind (e.g., the greenhouse effect, the destruction of South American rainforests, ocean pollution, etc.) can be recast in commons dilemma terms. Within psychology, the bulk of commons dilemma research has focused on identifying factors that increase cooperation among consumers (and hence resource management efficiency) of shared resources.

A quantitative synthesis of over 20 years of commons dilemma research is presented. The results of series of meta analyses suggest the relation between eight factors (moral suasion, forced equal outcomes, previous experience, communication, group size, privatization, cooperative social values, resource pool feedback, and providing dilemma-related information and strategies) and cooperation/resource management efficiency are especially robust. Theoretical and methodological implications of the reported findings are discussed, as are suggestions for future research.

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CHAPTER 1

Introduction

In this era of overpopulation, global pollution, and rapidly diminishing resource stocks, resource allocation represents one of the most important issues facing humanity. One aspect of the allocation process, the commons dilemma, has become a popular research topic among psychologists. The present review represents the first quantitative synthesis of this research.

Social dilemmas are situations involving a conflict between individual and group interests. According to Dawes (1980), all social dilemmas share two general properties: (1) each individual in a group receives a higher payoff for self-interest actions (defection) than for public-interest actions (cooperation) regardless of how others act, and (2) the total payoffs associated with universal defection are lower than for universal cooperation. Often a temporal component is also involved; the negative consequences of self-interest actions may be delayed (Messick & McClelland, 1983).

Social dilemmas involving the use of a limited shared resource are known as commons dilemmas. The word "commons" was originally used to refer to jointly owned pastures on which herdsman could graze their cattle. The term is used more broadly today, typically referring to any desirable resource held jointly by a group of

individuals (Gifford, 1987). Commons can be ecological (e.g., fish, whales, forests, minerals, and clean air), financial (e.g., joint bank accounts, and federal government funds), domestic (e.g., food in the family refrigerator), or work-related (e.g., office stationery supplies and parking spots). Some of the most pressing problems presently facing mankind (e.g., the greenhouse effect, the destruction of South American rainforests, the pollution of our oceans, rapidly diminishing stocks of food and fossil fuels, etc.) can be recast in commons-dilemma terms.

The dilemma itself is essentially a decisional one. Each consumer must decide whether to limit his or her consumption (a choice that may benefit the group in the long-run), or to maintain usage at present levels and thereby threaten the future of the common pool (Edney, 1980; Gifford, 1987). Those who choose to limit their use of certain resources place themselves in a vulnerable position. They relinquish the benefits associated with high levels of consumption (e.g., large short-term profits stemming from resource sales), yet are given no guarantee that others will also display restraint and not extinguish the resource. Clearly, unless there is some reason to believe that others will also act responsibly, conscientious behavior is not likely to be rewarded.

Historical Antecedents to Commons-Dilemma Research

Humans have a long history of mismanaging certain natural resources. Overgrazing has, time and time again, led to the destruction of once fertile rangeland [e.g., the (once) fertile crescent running through what is now Iran and Iraq, the Sahel region of Africa, etc.]. Many historians believe that the fall of Greece and Rome can be partly attributed to land misuse (Chiras, 1988). Aristotle seems to have recognized the root of the problem:

> What is common to the greatest number gets the least amount of care. Men pay most attention to what is their own; they care less for what is common; or at any rate, they care for it only to the extent to which each is individually concerned. Even when there is no other cause for inattention, men are more prone to neglect their duty when they think another is attending to it...(cited in Waldron, 1988, p. 6).

The first explicit treatment of the commons dilemma was presented by the English political economist W. F. Lloyd in a lecture on population checks delivered at Oxford University in 1832. Lloyd (1837/1968, pp. 31-32) used a parable involving a group of herdsmen and a common

pasture to outline the problem. According to Lloyd, there are benefits and costs associated with adding cattle to one's herd. Herdsmen will only continue to add cattle as long as the benefits for doing so outweigh the costs. In the private pasture situation (i.e., whore each herdsman grazes his cattle on his own land), the benefits and costs of adding cattle are experienced directly by the individual herdsman. However, in the commons situation, each herdsman receives all the benefits associated with adding cattle, but only pays a fraction of the costs which are diffused equally among all other herdsmen sharing the pasture. In other words, the checks controlling population in the private pasture situation are removed in the commons situation resulting in the demise of the common and ultimately of the cattle that graze there.

Lloyd's notions were popularized and extended to contemporary population and ecological problems by biologist Garrett Hardin (1968). In his seminal article "The Tragedy of the Commons", Hardin (like Lloyd) asserts that unregulated use of the commons will bring ruin to all. Hardin suggests that in many situations (i.e., when the common is land or some other easily divisible resource) destruction of the common can be averted by dividing it up into privately owned (or managed) territories. However, when dealing **with commons that are**

not readily divisible (e.g., oceans, rivers, the atmosphere, etc.), Hardin advocates the introduction of mutually agreed-on coercive laws or taxing systems to facilitate public interest behavior. Hardin admits his "coercive solution" may not be compatible with traditional conceptions of personal freedom. However, he believes such a solution is necessary if the "tragedy of the commons" is to be avoided.

A number of commons-dilemma researchers (e.g., Dawes, 1980; Gifford, 1987) have contrasted the views of Lloyd and Hardin with those expressed by the 18th century Scottish economist Adam Smith (1776/1976). According to Smith, in a laissez-faire capitalist society, the self-interested individual (i.e., one who seeks his or her own economic advantage) is inadvertently guided by *an* "invisible hand" to contribute to the welfare of others.

> He generally, indeed, neither intends to promote the public interest, nor knows how much he is promoting it-and by directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain, and he, in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention...By pursuing his own interest he frequently

> promotes that of the society more effectually than when he really intends to promote it (p. 477).

Smith's views with respect to the external effects of self-interested behavior seem to be diametrically opposed to those of Lloyd and Hardin. However, as Dawes (1980) has noted, the two sets of theorists may have been discussing different situations. Hardin and Lloyd's discussions focus on resources that are owned by "no one in particular", whereas Smith's view assumes the presence of a competitive market in which resources are privately owned (M. Rutherford, personal communication, August, 1990). Dawes (1980) states,

> Hardin's is a dilemma situation in which the external consequences of each herdsman's trying to maximize his profits are negative, and the negative consequences outweigh the positive ones to him...Smith's situation is a non-dilemma one, in which maximizing individual profit does not hurt others more than it benefits the individual, in fact it helps them.

As noted earlier, Hardin advocates the use of coercion as a potential solution to the commons problem. Others (e.g., Heilbroner, 1974; Hobbes, **1651/1947;**

Ophuls, 1977; Platt, 1973) have also indicated that some form of authoritarian intervention may be necessary to solve certain social problems. Coercive solutions are often viewed as unacceptable violations of the personal freedoms which supposedly form the basis of western society. From a dialectical perspective this position seems suspect. In order to have freedom, there must also be constraints. For example, our freedom to live peacefully in natural settings requires that others are prevented from these settings. Note that many coercive systems already exist (and in some cases are taken for granted) to help preserve those things that society values; consider your local police force, the Environmental Protection Agency, the Internal Revenue Service, utility companies, etc.

In addition to personal freedoms, practical reasons are also given for rejecting coercive solutions to commons problems. Dawes (19 80) notes that coercive solutions are generally costly and inefficient. Most require the creation of a superordinate authority to ensure rule-following. Such bureaucratic entities tend to be expensive to sustain and deprive the economy of potentially productive workers. Furthermore, according to Dawes, coercive systems often motivate people to find loopholes in the rules. Systems designed to deter

environmental misuse may, in some situations, actually encourage it.

Most psychologists probably would agree that non-coercive solutions to commons dilemmas are preferable to coercive ones, and the research reviewed appears to reflect this bias. However, given the pressing nature of many of our resource problems, it might be useful to systematically compare the benefits, costs, and effectiveness of the two types of solutions. It may well turn out the philosophically preferred solution is not the most practical one. Research Paradigms

Commons dilemmas are generally studied in laboratory settings, although some field studies have been done (e.g., see Acheson, 1975; Wilson, 1975). Two experimental paradigms (the replenishabie resource paradigm and the N-person prisoner's dilemma paradigm) are prevalent.

The replenishable resource paradigm. Most laboratory studies conform to what Messick and Brewer (1983) have labelled the "replenishable resource" paradigm. In this paradigm, a group of participants share access to a limited pool of points that can be exchanged for money or prizes at the conclusion of the experiment. In most studies, subjects are sensitized to similarities between experimental task and real world

resource problems. The pool replenishes itself at a predetermined rate and generally cannot exceed some maximum amount. Participants are instructed to do two things: (1) harvest as much of the resource as possible during the course of the experiment, and (2) attempt to make the resource pool last as long as possible. The simulation usually proceeds for approximately 10 rounds (with each subject making one harvest per round) or until the resource is extinguished. Generally, subjects are not told the number of rounds to be played, preventing the occurrence of "end of the game" effects (if participants know when the game is to end, there is no motivation to conserve the resource during the final round). The experimenter often limits the amount of the resource that can be harvested by each participant in each round. Feedback regarding the state of the resource pool and the harvests made by others is usually (but not always) given at the end of each round.[2] The optimal group harvesting strategy involves keeping the pool near its maximum (given such a maximum exists) by striking a balance between resource use and resource replenishment. A variety of dependent measures have been used with the replenishable resource paradigm. The most common are:

(1) The total number of resource units harvested by a group. Given that a conservative strategy (i.e., not

taking more from the pool, than can be replenished in any-given round) results in an optimal harvest in the long-run, larger total harvests are associated with superior resource management relative to smaller total harvests. One limitation of the "total harvest" measure is that it fails to distinguish between low overall harvests stemming from (a) rapid resource extinction (i.e., the resource pool being extinguished by overharvesting) and (b) resource underuse (i.e., what might called "over-conservation", a strategy promoted by some environmentalists). A new measure of resource management effectiveness that overcomes this limitation was developed by Tindall and O'Connor (1987). The "Observed-Ideal Difference Index Score" (OIDXS) measures the average difference between the observed harvest and the harvest corresponding to the ideal resource management strategy. Resource overuse is characterized by a positive OIDXS score, whereas a negative score suggests underuse.

(2) The number of rounds played before the resource pool is depleted. The long-term survival of the resource pool is generally accepted as an indication of effective resource management. However, it may also reflect resource underuse.

Both measures described above assess the quality of resource management in terms of group performance. That is, the unit of analysis is the group.

(3) The number of resource units harvested by each individual during each round. Generally, larger harvests are interpreted as reflecting self-interest behavior, whereas smaller harvests represent public-interest behavior. Although this measure is frequently used by commons-dilemma researchers (e.g., Samuelson & Messick, 1986; Brewer & Kramer, 1986), it represents a potentially ambiguous measure of resource management effectiveness. For example, in situations where the resource pool is being overused, high individual use is inconsistent with the interests of the group sharing the resource. However, if the resource pool is being underused, high individual use (provided it is not too high) is neither irresponsible nor inconsistent with group interests. The advantage of the individual harvest rate measure is that it allows researchers to examine how individual harvesters respond to different resource conditions, game rules, etc. The first two dependent measures described above do not permit the analysis of individual behavior.

The N-person prisoner's dilemma paradigm. A second, and perhaps the most common, paradigm used to study social dilemmas (of which the commons dilemma is a special type) is the N-person prisoner's dilemma (NPD).

In the NPD paradigm, participants, in groups of 3 or larger, must choose one of two options: defection or cooperation. The payoffs for defection are higher than those for cooperation, making defection the dominant strategy (cf. discussion of game theory in Chapter 2). However, each defecting choice within a group results in decreased payoffs to all other group members. Moreover, if all group members defect, all receive lower payoffs than if everyone cooperates.

In most NPD studies, *as* in the replenishable resource paradigm, choices are made repeatedly over a number of trials. Research involving two-person prisoner's dilemma games suggests that the iterative process may play an important role in the development of cooperation. Axelrod (1984), in particular, has argued that the adoption of a Tit for Tat strategy (i.e., a strategy in which one's own choice mirrors that of an opponent from the previous round) may be an especially effective method for fostering cooperation. Unfortunately, the effectiveness of Tit for Tat depends on the presence of two factors (reinforcement control and the ability to identify defectors) that are not present in N-person situations.

(1) Reinforcement control. In a two-person game, each player can "shape" the choices of his or her opponents (Dawes, 1980). That is, each player **can punish**

or reward an opponent's previous choice by defecting or cooperating during the subsequent round. In standard NPD games "reinforcement control" is substantially reduced. The punishing or rewarding effects of one's choice are spread over all group members and cannot be directed towards specific individuals.

(2) Ability to identify defectors. In two-person games defection is never anonymous; players are always aware of the choices made by their opponents (Dawes, 1980). In NPD games, this is not the case. As group size increases, it becomes increasingly difficult to identify who is cooperating and who is defecting. As a result, even if a mechanism exists to punish defectors during subsequent trials (although this would not characteristic of a standard NPD game), it may difficult to determine exactly who know deserves to be punished.

In sum, it appears that iteration probably plays a less important role in the development of cooperation in NPDs than in two-person games. In NPDs, repeated trials may provide participants with useful information about the strategies employed by other players. This information may be an important factor in the development or lack of development of trust and cooperation as the game progresses. However, relative to the two-person games, the power of NPD participants to identify defectors and utilize their own responses to shape the

actions of their opponents is substantially reduced. Thus, unlike in the 2-person game, the entrapping quality of the NPD is not substantially altered by the iterative process (Messick & Brewer, 1983).

Differences between paradigms. The NPD paradigm differs from the replenishable resource paradigm in two important ways. First, NPDs are not characterized by a diminishing resource pool. As a result, NPDs fail to capture the dynamic nature of the commons dilemma. In NPDs the resource pool is inexhaustible, and payoffs continue every round regardless of the number of non-cooperative responses. In the replenishable resource paradigm, payoffs depend on the preservation of the resource. Subjects may, therefore, be more motivated to cooperatively resolve the dilemma. Second, participant responses in NPDs are limited to cooperation or defection. The replenishable resource paradigm permits participants to engage in variety of responses ranging from taking nothing to harvesting the maximum allowed by the experimenter. This seems less restrictive (and contrived) than the forced choice system used in NPD studies.

Although NPDs do not share all the characteristics of commons dilemmas, the two types of dilemmas are conceptually similar (i.e., both conform to Dawes* formal definition of social dilemmas) and results are often

generalized across paradigms (e.g., see Dawes, 1980; Edney, 1980; Messick & Brewer, 1983). The fact that such generalizations are commonly made seems to imply that there exists a relationship between cooperation and resource management effectiveness. It seems reasonable to expect that effective resource management by a group requires that the individual members of that group cooperate with each other. Although this may turn out to be true, none of the three measures commonly used in the replenishable resource paradigm measures cooperation directly, therefore generalizations should be made cautiously. One of the goals of this review, in fact, is to determine whether cross-paradigm generalizations are justified.

Limitations of laboratory simulations. One of the main advantages of laboratory research is that situations can be created in the lab that would be "impractical, impossible, or unethical to create in the real world" (Messick & Brewer, 1983, p.37). Laboratory studies also allow researchers to exercise a degree of control over the experimental setting, something that is not usually possible in field studies.

Despite these advantages, laboratory research has a number of problems, mostly relating to the issue of generalizability. Most lab experiments are "lousy simulations of the social dilemmas with which most of us

are concerned" (Dawes, 1980, p.188). Laboratory dilemmas tend to be smaller in scale, and involve less valuable payoffs than dilemmas found in the real world. Furthermore, most social psychology experiments (although not all, see Liebrand, 1984) use university undergraduates as subjects. According to Dawes,

> Findings about how small groups of such students behave in contrived situations cannot be generalized to statements about how to save the world."[3] At best, they can help us understand some of the processes that may be operating in real world dilemmas.

Factors Influencing Cooperation/Resource Management Efficiency

Most commons-dilemma research has focused on identifying those factors that increase cooperative behavior or overall resource management efficiency. According to Gifford (1987), the factors influencing cooperation/resource management efficiency can be divided into three main catagories: (1) resource characteristics, (2) participant characteristics, and (3) rules of the game. A list of the specific factors thought to influence cooperation/resource management is displayed in Table 1.1.

Table 1.1: Factors influencing cooperation/resource management efficiency in commons dilemmas (based on Gifford, 1987) .

RESOURCE CHARACTERISTICS

(a) Whole versus subdivided resources (Acheson, 1975; Cass & Edney, 1978; Edney & Bell, 1983; Martichuski & Bell, 1990; Messick & McClelland, 1983; Wilson, 1977) .

(b) Resource use (Kramer & Brewer, 1984; Kramer et al., 1986; Messick et al., 1983; Rutte & Wilke, 1984; Samuelson, 1990; Samuelson & Messick, 1986a; Samuelson & Messick, 1986b; Samuelson, et al. 1986; Schroeder et al., 1983).

(c) Pool size (Brechner, 1977).

(d) Cause of resource abundance or scarcity (Rutte, Wilke, & Messick, 1987b).

PARTICIPANT CHARACTERISTICS

(a) Gender (Caldwell, 1976; Fleishman, 1988; Fox & Guyer, 1978; Gifford, 1982; Goehring & Kahan, 1976; Hamburger et al., 1975; Kramer & Brewer, 1984; Liebrand, 1984; Liebrand & Van Run, 1985; Meaux, 1973; Moore et al., 1987; Powers & Boyle, 1983; Rutte et al., 1987) .

(b) Personality (Bixenstine & Douglas, 1967; Meux, 1973).

(c) Previous experience with social dilemmas (Allison & Messick, 1985; Gifford, 1982).

(d) Social (individual versus group) identity (Baird, 1982; Brewer & Kramer, 1986; Grzelak & Tyszka, 1974; Kramer & Brewer, 1984; Tindall & O'Connor, 1987).

(e) Social (cooperative versus competitive) values (Alcock & Mansell, 1977; Kramer & Brewer, 1986; Liebrand et al., 1986; Samuelson, 1990).

(f) Trust (Brann & Foddy, 1987; Messick et al., 1983; Moore et al., 1987; Tindall & O'Connor, 1987).

(g) Variance in others' harvests (Messick et al., 1983; Rutte & Wilke, 1984; Samuelson, 1990, Samuelson & Messick, 1986ab, Samuelson et al., 1984).

(h) Age (Gifford, 1982).

(i) Perceived attitude similarity of group members (Smith, Bell, & Fusco, 1988). (j) Culture (Liebrand & Van Run, 1985).

RULES OF THE GAME

(a) Communication among group members (Bixenstine & Douglas, 1967; Bixenstine et al., 1966; Brechner, 1973; Caldweil, 1976; Dawes et al., 1977; Edney & Harper, 1978; Harper, 1977; Grzelak & Tyszka, 1974; Jorgenson & Papciak, 1981; Liebrand, 19 84; Rapoport et al., 1962; Bell et al., 1990).

(b) Decision Framing (Brewer & Kramer, 1986, Fleishman, 1980, Rutte et al., 1987a)

(c) Forced equal resource allocation (Edney & Bell, 1983, 1984, 1987).

(d) Feedback about others' choices or harvests (Bixenstine et ai., 1966; Foddy, 1974; Grzelak & Tyszka, 1974; Schroeder et al., 1983).

(e) Moral suasion (Edney & Bell, 1983; Martichuski & Bell, 1990).

(f) Payoffs (Bruins et al., 1989; Grzelak & Tyszka, 1974; Kelley & Grzelak, 1972; Schroeder & Johnson, 1982).

(g) Public versus private choice (Fox & Guyer, 1978; Jorgenson & Papciak, 1981; Schroeder et al., 1983).

(h) Resource Pool Feedback (Cass & Edney, 1978; Jorgenson & Papciak, 1981; Kline et al., 1984; Schroeder et al., 1983). (i) Group size (Allison & Messick, 1985; Bonacich et al., 1976; Brewer & Kramer, 1986; Hamburger et al., 1975; Komorita & Lapworth, 1982; Komorita et al., 1980; Liebrand, 1984; Marwell & Schmidt, 1972; Messick & McClelland, 1983; Powers & Boyle, 1983). (j) Providing dilemma-related information and strategies (Edney & Harper, 1978; Rapoport, 1988; Schroeder et al., 1983; Stern, 1976).

(k) Presence of reward and punishment (Bell et al., 1989; Caldwell, 1976; Foddy, 1974; Kline et al., 1984; Komorita & Barth, 1985; Martichuski & Bell, 1990; Powers & Boyle, 1983; Stern, 1976).

(1) Access to the resource (Samuelson & Messick, 1986).

(m) Perceived task difficulty (Samuelson, 1990). (n) Number of rounds played (Schroeder & Johnson, 1982). (o) Time to reflect about one's choice (Dawes & Orbell, 1982).

Researchers (e.g., Samuelson & Messick, 1986) have also examined factors that lead to collective group action to change the group's decision-making structure (i.e., subjects may vote to give up free access to a resource in favour of a leader, who would be responsible for the group's harvest decisions). Relatively few studies of this sort have been published, but interest in this area seems to be increasing. So far, only one factor (resource overuse) seems to consistently lead to collective decisions in favour of structural change. The

Present Review

An integrative review of commons-dilemma theory and research is proposed.

The Need for a Comprehensive Quantitative Review. There are several compelling reasons why a comprehensive

quantitative review of commons-dilemma research is needed.

(1) The absence of a recent review. The most recent review was conducted by Messick and Brewer in 1983.[4] Since 1983, at least 60 new commons-dilemma articles have been published. Thus, a significant amount of new data exists that has yet to be summarized and integrated with existing information.

(2) The absence of a quantitative review. All previous reviews in the area have been primarily theoretical and descriptive; no attempt has been made to quantitatively synthesize past research findings. The use of quantitative techniques in psychological reviews is becoming increasingly common and, if appropriately applied, should increase the validity of review conclusions (Cooper, 1984).

(3) An apparent lack of integration of past findings into present research and theory. Two features of the commons-dilemma literature suggest the need for an integrative review. First, one group of researchers has recently proposed a 3-factor model of harvest decisions. Although this model is supported by their own research (which characteristically utilizes only variables that influence the three hypothetical factors), it ignores the multitude of other factors shown in previous studies to influence harvest decisions. Certainly, a model that

considers all relevant factors would be more useful than one that relies solely on the results of one research group.

Second, commons-dilemma research is presently being conducted in four culturally distinct parts of the world: North America, the Netherlands, Australia, and Japan. The research being done in different countries appears to be conceptually similar and often involves comparable independent and dependent variables. Although some cross-cultural studies have been reported (e.g., Samuelson, Messick, Rutte, & Wilke, 1984), no systematic comparison of cultural differences seems to have been attempted.

Objectives of this review. The proposed review has three main objectives. First, it will critically evaluate commons-dilemma theory. Three general perspectives on the commons problem (psychological, economic, and developmental) will be presented. Second, a comprehensive quantitative summary (i.e., meta-analysis) of factors influencing cooperation in commons-dilemma situations will reported. This summary will include: (1) the overall probability that a series of related results (i.e., results from studies testing the same general hypothesis) could have been generated if the null hypothesis was true for all of the studies, (2) an overall effect size for each series of related results.

and (3) a list of potential moderating factors (e.g., cultural background of subjects, research paradigm, etc.) that may account for observed differences In effect sizes between separate studies testing the same hypotheses. Finally, unresolved issues and gaps in the literature will be identified and a research agenda will be presented to help guide further research. Organization of the Thesis

The remainder of the thesis will be organized into five sections (chapters 2 through 6). Chapter 2 will consist of a review of commons-dilemma theory. Chapter 3 contains an overview of meta-analysis. The methods used to prepare this review are included in chapter 4. A quantitative summary of the commons-dilemma literature will be presented in chapter 5. A discussion of the meta-analyses and suggestions for future research will be discussed in chapter 6.

Footnotes

[X]A view counter to that of Ornstein and Ehrlich is expressed by Julian Simon (1981) in his book "The Ultimate Resource."

[2]The feedback provided to each subject about the harvest decisions made by the other group members is often preprogrammed into a computer and does not reflect the actual behavior of chose members (e.g., see Brewer & Kramer, 1986; Samuelson & Messick, 1986).

[3]Even though social dilemma simulations often lack face validity, many studies report participant behavior that is similar to that expected in real world dilemmas (e.g., threats against defectors, crying, yelling, etc.). This suggests that these simulations may not be as unrealistic as might be thought.

[4]Earlier reviews of social dilemma research include those performed by Dawes (1980), Dawes and Orbell (1981), Edney (1980, 1981), Edney and Harper (1978), and Strobe and Frey (1982). A new book on social dilemmas edited by D. A. Schroeder is forthcoming.

CHAPTER 2 The Commons Dilemma: Three Perspectives

In this chapter the commons dilemma will be examined from three general theoretical perspectives (psychological, economic, and historical). Each perspective provides a unique view of the problem and suggests ways in which it best may be solved.

A Psychological Perspective

A variety of psychological theories and models have been proposed to explain the behavior of groups and individuals in social dilemmas. Six of these theories will be discussed briefly.

Limited Processing Theory

Limited processing theory (Dawes, 1980) focuses on the link between cognition and cooperative behavior. According to Dawes (1980), behavior in social dilemmas is guided by two main factors: the payoffs and the personal utilities associated with cooperation and defection. Payoffs refer to the magnitude of the rewards (and/or punishments) associated with cooperative and non-cooperative behavior. In all social dilemmas the individual payoffs for defection are greater than those for cooperation. Thus, if behavior is guided exclusively by payoffs, one would expect everyone to defect.

Experience with real-world dilemmas and experimental simulations reveals that global defection rarely occurs; in most cases at least some individuals attempt to cooperate. This suggests that factors other than payoffs must also influence behavior. Dawes identified three factors (altruism, social norms that encourage cooperation, and one's own conscience) that might lead people to forego a large immediate payoff in favor of cooperation. He labelled these factors "personal utilities".

Dawes suggested that the complexity of most social dilemmas prevents us from fully comprehending the implications of our actions. There is too much information to process in a short period of time. To cope with this excess of information we typically attend to only the most salient aspects of the situation, which in the case of commons dilemma is usually the payoff structure. If individuals process only information about short-term payoffs, defection may appear to be the only sensible option available.

Solutions. Limited processing theory suggests three potential solutions to the commons problem. First, it suggests that cooperation can be increased by educating individuals about the nature of the dilemma. Once the harvesters possess the basic tools needed to efficiently manage the resource, they should feel less cognitively

overwhelmed by the task at hand. Second, limited processing theory suggests that interventions that invoke feelings of altruism, morality, and responsibility in group members should also help preserve the commons by drawing the harvesters' attention away from the payoff stucture. Finally, providing individuals with more time to think about their resource use decisions may also increase cooperation. Harvesters would be able to contemplate both the nature of the dilemma and the moral implications of their actions. Social Trap Theory

Social trap theory (Cross & Guyer, 1980; Platt, 1973) represents an attempt to explain a host of social problems from a behaviorist perspective. Social traps refer to situations in which reinforcement contingencies are arranged in such a way that *an* individual's actions are self-gratifying in the short-run, but ultimately lead to negative consequences in the long-run. In the words of Messick and Brewer (1983),

> We are lured into the trap by our short-term self-interest, ignoring the long-term collective costs; the trap is sprung when the future collective costs must be paid.

Social traps can be classified according to three dichotomous dimensions (individual versus collective,

immediate versus delayed, and traps versus counter-traps).

(1) Individual and collective traps. A common type of individual (or single-person) trap typically involves activities that bring short-term pleasure or relief, but have long-term health costs (e.g., smoking and drug misuse). Traps in which negative outcomes stem from the actions of more than one person (e.g., the commons dilemma and most other types of social dilemmas) are known as collective traps.

(2) Immediate and delayed traps. Negative outcomes may immediately follow actions or they may be delayed in time. According to Messick and Brewer (1983), immediate craps are generally self-limiting in the sense that actions directly followed by punishing outcomes are usually suppressed. Unfortunately, most commons dilemmas are characterized by delayed negative consequences. Consider that some of the long-term negative consequences of mass industrialization (e.g., acid rain, the greenhouse effect, resource depletion, etc.) are only now being realized, more than 200 years following the beginning of the industrial revolution.

Delayed consequences are problematic for at least two reasons. First, in some cases they are difficult, if not impossible, to predict. When manufacturers first started using CFCs in refrigerators and aerosol cans,

they had no idea of the effects these compounds might have on the earth's ozone layer. Second, delayed consequences tend to be less psychologically salient than immediate consequences. This phenomenon is known as "time discounting" (cf. economics section). According to Taylor (1988), "The further off in time certain bad consequences are the more we devalue that negative impact, the more trivial it seems to us." This being the case, immediate impacts tend to exert a stronger influence on behavior than long-term outcomes.

(3) Traps and counter-traps. All of the traps discussed so far have involved situations characterized by short-term rewards and long-term costs. A second type of trap, usually called a counter-trap or a social fence, involves situations in which short-term aversive consequences prevent individuals or groups from performing actions leading to long-term benefits. For example, a fear of hospitals may prevent an individual from receiving a much-needed operation. Like traps, counter-traps can be delayed, immediate, collective, or individual. The public goods dilemma represents an example of a collective, delayed social fence.

Solutions. Social trap theorists (e.g., Cross & Guyer, 1980; Platt 1973) have outlined a variety of ways to prevent or escape from social traps. A number of these are especially relevant to solving real world

commons dilemmas. For example, Platt (197 3) suggested that regulatory agencies could be established to introduce counter-reinforcers (such as taxes, subsidies, etc.) to deter potential defectors. Counter reinforcers could be used to make the long-term negative consequences for noncooperative behavior more immediate, and/or simply to increase the rewards associated with less destructive alternative actions (i.e., cooperative behavior). Many such regulatory agencies (e.g., the Environmental Protection Agency in the United States) are already in place.

A second possible solution involves the introduction of new technological innovations to help minimize the negative long-term consequences of certain actions. For example, state-of-the-art purifiers could be developed to detoxify the effluent flowing from pulp mills. If the new technology is affordable (or subsidized) and effective, both industry and the environment will benefit.

Limitations. Although social trap theory provides useful insights into a variety of social and ecological problems, it is limited in a number of respects. First, as Taylor (1981) has noted, the social trap perspective has nothing to say about the distribution of benefits **and** costs associated with certain actions. Often those **who** reap the short-terra benefits are **not** those **who** must **pay**

the long-term costs. For example, consider the case of a foreign-owned pulp mill that fouls a nearby lake. Company stockholders may benefit by management's decision not to install anti-pollution equipment, but much of the cost of this decision is paid by the locals who can no longer use the lake for fishing or recreation. A second limitation of social trap theory is that it tends to put too much emphasis on overt behavior, while ignoring important cognitive and personality factors (e.g., the personal utilities suggested by Dawes). Surely, any complete account of human behavior must also include accounts of cognition and personality. Equity Theory[1]

Equity theory focuses on how scarce resources are allocated among individuals in groups. The theory suggests that norms exist in our society that encourage just and equitable behavior. According to Homans (1961, cited in Edney, 1981), an equitable situation is one in which:

$$\frac{\text{A's Rewards - A's Costs}}{\text{A's Investments}} \quad \frac{\text{B's Rewards - B's Costs}}{\text{B's Investments}}$$

In other words, one's net gain should increase in direct proportion to one's inputs. Thus, according to equity theory, those who contribute to the maintenance of the commons (e.g., by constructing fences and irrigation

systems) should be entitled to commons-related benefits (e.g., larger harvests or more cattle) than those who contribute nothing.

Inequitable situations can be resolved in at least two ways. First, balance can be reinstated behaviorally (i.e., through physical action). Workers who believe that they are being treated unfairly by management may go on strike or engage in work slow-downs. In instances characterized by severe injustices, methods involving violent confrontation may be used to overthrow an existing allocation system in favour of one that distributes rewards more justly. On the other hand, inequitable situations are often made to seem more equitable through cognitive distortion. According to Edney (1981)

> Psychological adjustments such as telling himself the situation was not important, derogating the exploited person after the exchange, denying responsibility for the behavior, minimizing the suffering involved, and other means of reducing dissonance all occur.

The notion of equity seems to be implicitly **built into the market economies characterizing most Western** societies. Salaries **tend to reflect the value society**

places on specific work skills. Those with highly prized skills (e.g., doctors and professional athletes), tend to receive larger salaries which in turn provides them with increased access to many scarce and/or highly valued resources. Thus, as equity theory suggests, those with more valuable inputs tend to reap greater benefits.

Limitations. A major drawback of equity theory, when applied to commons-dilemma research, is that it fails to take into account the finite nature of many resources. According to Gifford (1987),

> if there are too many individuals, ail working hard, the pool of resources cannot provide all of them with their just rewards.

A second problem with equity theory involves the issue of comparing inputs. Equity theory suggests that rewards should be proportional to Inputs. Yet inputs come in a variety of shapes and sizes, many of which can not be compared directly. How many hours of basic labour is equivalent to one brilliant idea? Who contributes more to society, entertainers or academics, environmentalists or industrialists?

A final problem with equity theory stems from evidence suggesting that the equity norm may not be as strong as once believed. Research has shown that some people prefer to distribute resources according to need,

Furthermore, Calabresi and Bobbitt suggest that particular allocation strategies are chosen by those in power with two malevolent intents: (1) to hide the fact that most scarcity is directly linked to conscious decisions made by those who control the resources, and (2) to obscure the conflict between the reality of unequal allocations and the Western ideal that all citizens can expect equal treatment.

How is tragic choice theory related to individual resource use? Gifford (1987) suggests that individuals may engage in self-interested behavior because they accept present allocation mechanisms as a justification for over-using the commons. For example, a logging firm may justify its use of irresponsible and wasteful practices by claiming that it is operating according to the rules of a larger system (e.g., a government controlled regulatory agency). Thus, responsibility (and guilt) is removed from the firm and passed on to a third party.

Solutions. Although Calabresi and Bobbitt offer no technological or institutional solutions, the theory is prescriptive in the sense that it advocates honesty, responsibility, and awareness of the relation between one's choices and the suffering of others (Edney, 1981). Unfortunately, the theory is difficult to test because

> some of its tenets seem to preclude its own verification; if, in fact, there is dishonesty and collusion in the scarcity system, it will be difficult to obtain the very data needed to test that...(Edney, 1981).

The Three-Factor Model of Harvest Decisions.

The three-factor model of harvest decisions represents Messick et al's (1983) post-hoc attempt to explain their research findings. The authors proposed that harvest decisions in a replenishable resource task are guided by three (often) conflicting motives: (1) a desire to use the resource responsibly but efficiently, (2) a desire to conform to implicit group norms, and (3) willingness to trust others. According to the model, the weights associated with each of the motives vary depending on the presence or absence of other situational factors. For example, situations in which the harvest rates of the other group members are highly variable should decrease conformity pressure relative to situations where all members harvested more or less equal amounts of the resource. Willingness to trust other group members should become an especially important motive when the resource pool is severely overused.

Limitations. The major problem with the three-factor model is one of completeness. Why were

responsibility, conformity, and trust selected as the three basic motives? How are the host of other factors that have been shown to influence harvest decisions (e.g., communication, group size, personality factors, experience, etc.) related to these (and other) motives? Questions such as these must be addressed before this model can be given serious consideration. Game Theory

Game theory is a branch of mathematics that focuses on theoretical solutions to a variety of group activities. Although many real-world situations are too complex to be completely explained in game theoretical terms, certain aspects of game theory provide insight into some of the basic processes underlying group behavior.

Types of games. Most games can be classified according to three dichotomous criteria (zero-sum versus non-zero-sum games, cooperative versus non-cooperative games, and symmetrical versus non-symmetrical games). In zero-sum games, the gains and losses of all players must sura to zero. For example, at the end of a poker game the total amount of money lost at the table is always equal to the total amount of money won. The outcomes of non-zero-sum games, on the other hand, need not balance to zero. If all players cooperate, all can gain. However,

if all players act selfishly or competitively, all will lose.

Games may also be classified as being cooperative or non-cooperative. Games that permit communication and the development of cooperative agreements are called cooperative games. Those not allowing communication nor providing alternative mechanisms to establish binding contracts are called non-cooperative.

Finally, games may be symmetrical or asymmetrical. In symmetrical games all players are faced with the same payoff matrix, whereas in asymmetrical games different players face different payoff structures. Most commons-dilemma simulations (e.g., NPD and replenishable resource games) are symmetrical, non-cooperative, non-zero-sum games. However, some simulations allow communication (or other means for establishing binding contracts) and are therefore considered to be cooperative games.

Individual rationality and the principle of dominance. In most games, participants must choose between two responses (e.g., choice A and B), each associated with a different payoff structure. The payoff associated with each choice typically changes depending on the choices made by the other group members. Choice A is said to be dominant over B if players receive a higher payoff for choosing A than for choosing B, regardless of the choices made by the other group members. Thus, the

principle of dominance is concerned exclusively with individual rationality; it is always in the individual's best interest to choose the dominant over the non-dominant option. Although many games have no dominant strategy (e.g., games capturing certain aspects of oligopolies), commons-dilemma simulations are always characterized by a dominant option.

Theoretical solutions to games are usually based on the assumption that all players will act rationally, that is, choose the dominant option (assuming that a dominant option exists). Note, however, that in some situations (e.g., commons dilemmas) the individually rational solution to a game is not always the optimal solution. For example, in Hardin's commons parable, herdsmen must choose between adding and not adding cattle to a commonly held pasture. Adding cattle is clearly the dominant strategy; regardless of what the other herdsmen do, the payoffs for adding cattle are always higher than for not adding cattle. However, if all herdsman act rationally (i.e., adopt the dominant strategy and add cattle), the commons is destroyed and all are worse off than if all had adopted the non-dominant strategy (i.e., if no one had added cattle).

Solutions. Experimental games are used by psychologists and economists to study the basic elements of common property problems (e.g., the conflict between

individual and collective rationality). The dilemma is removed from its real world context (i.e., is presented in terms of two alternative choices, each associated with different payoff) and hypothetically relevant variables (e.g., group size, communication, trust, etc.) are systematically manipulated to determine their effect on cooperation. In recent years, the importance of contextual factors has been realized and more realistic simulations, such as the replenishable resource paradigm, have begun to replace traditional NPD studies.

An Economic Perspective

Like their counterparts in psychology, economists have developed a variety of theories and models to explain common property problems. In this section, three such models will be examined. The bulk of the discussion will focus on a basic economic model of renewable resource use. Aspects of the model related to free access, resource use inefficiency, and resource depletion will be highlighted. Two alternative models and potential economic solutions to common property problems will also be discussed.

A Basic Model of Renewable Resource Use

The following model represents the standard resource use model presented in most textbooks on resource economics (e.g., Norton, 1984). Although more complex

(and perhaps superior) models exist, this model was chosen because it clearly illustrates the relation between basic economic variables and inefficient resource use and depletion. The model will be explained in terms of a hypothetical fishery, however, the principles are general enough to be applied to almost any renewable resource.

Regeneration rates and maximum sustainable yields. A natural growth trend is evident in most fish populations. At low densities, populations tend to increase at an exponential rate. However, as density increases, limiting factors (such as disease, food shortages, and predation) cause the rate of growth to slow. Eventually, a balance between natality and mortality results and population size becomes relatively stable. The density at which this balance occurs is known as a setting's carrying capacity.

The relationship between the number of fish in the present time period and the number of fish in the subsequent time period is captured by what economist's call a fish recruitment curve (Norton, 1984). Because of the complex relation between environmental variables and population growth, and the obvious problems associated with estimating stock sizes, precise recruitment curves are difficult (if not impossible) to calculate. However,

through the careful monitoring of the fishery, curves can be produced that approximate reality.

Information about a fishery's biological regeneration rate can be used to generate a sustainable yield curve (see Figure 2-1). Each point on the sustainable yield curve represents a long-term equilibrium between a specific stock size and the per period consumption level associated with sustaining that stock size. The "inverted-U" shape of the curve suggests that the sustainable yield is maximized at only one level of stock (i.e., that level associated with the highest point on the curve). This is known as the maximum sustainable yield (or MSY). For the fishery described in Figure 2.1, the optimal stock level is 50 units and the MSY is 10 units per period. From a biological perspective, the MSY represents optimal efficiency in resource use.

The closed fishery. In the real word, harvest decisions tend to be guided by economic considerations rather than the MSY of the fishery. The basic assumption of the resource use model presented here is that harvesters will act to maximize personal profit. Figure 2.2 displays the total revenue and cost curves for a fishery operated by a single firm. The cost curve reflects the annual costs associated with different levels of effort (sustained over a long period of time)

Figure 1: Long-Run Sustainable Yield Curve

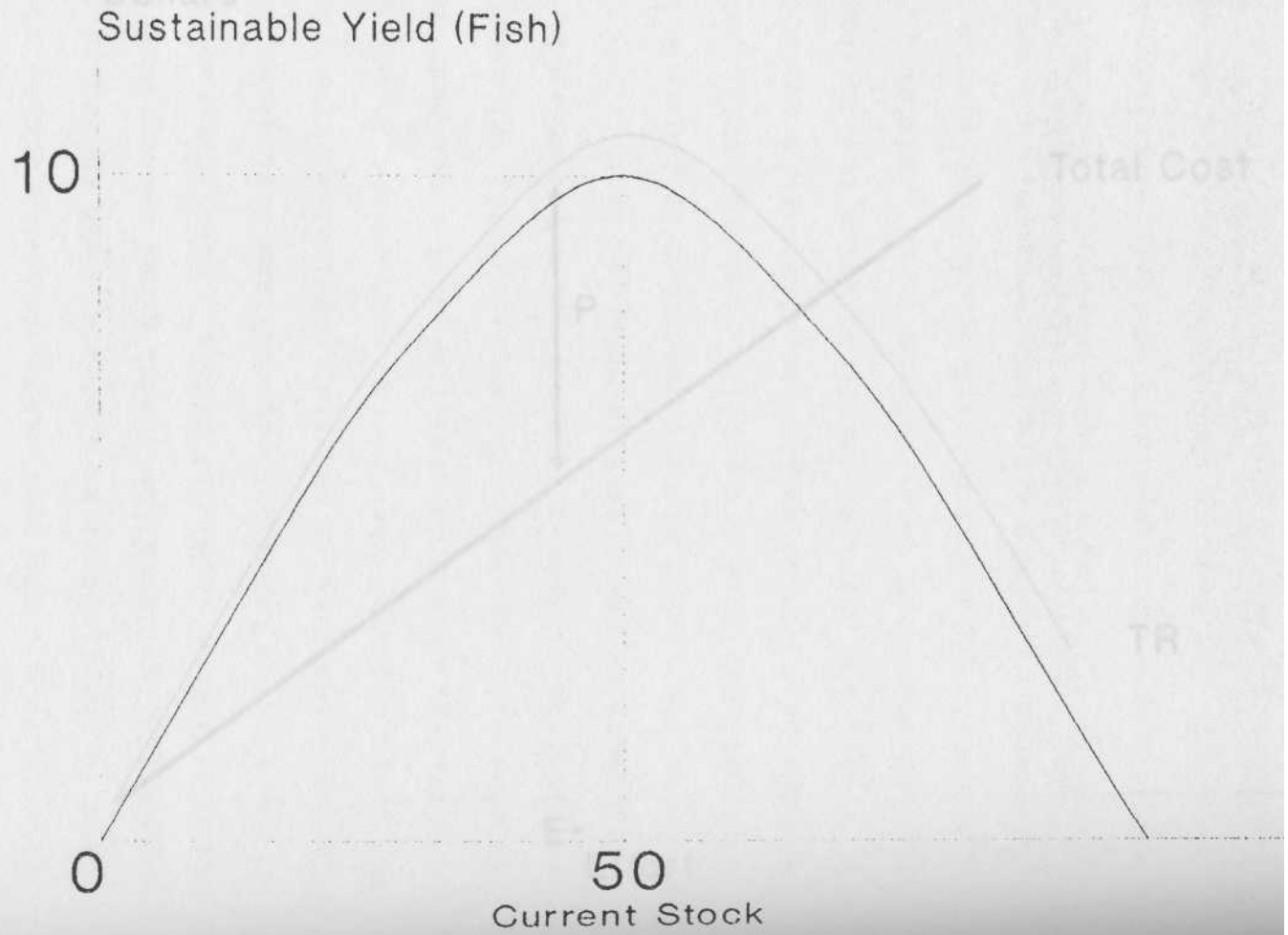
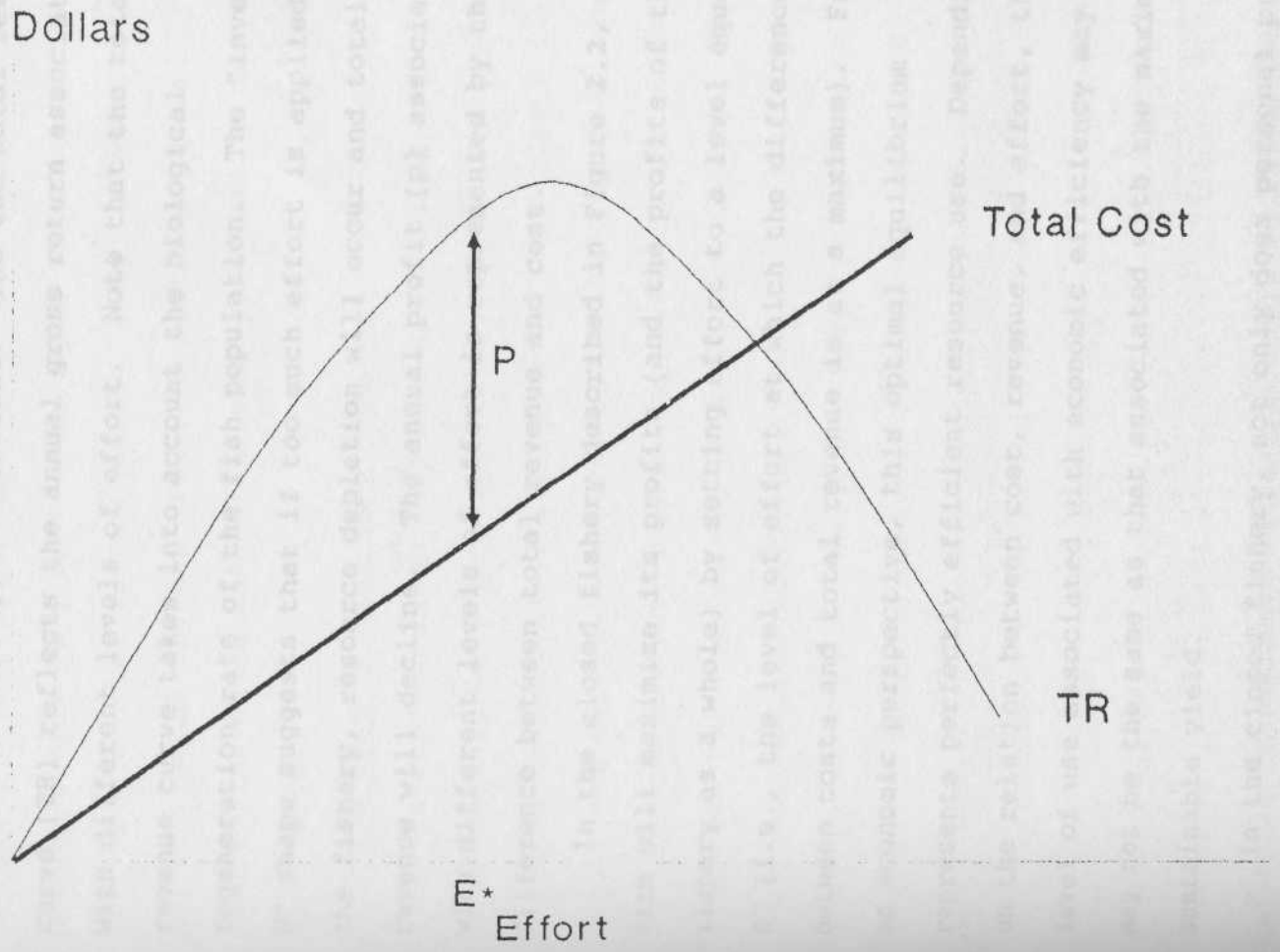


Figure 2: Cost and Total Revenue in a Closed Fishery.



In the fishery. Its perfectly straight shape suggests that the cost associated with each unit of effort In the fishery (e.g., the cost associated with adding one extra boat to the fishery) is constant. The total revenue curve (TR) reflects the annual gross return associated with different levels of effort. Note that the total revenue curve takes Into account the biological regeneration rate of the fish population. The "inverted-*U*" shape suggests that if too much effort is applied to the fishery, resource depletion will occur and total revenue will decline. The annual profit (p) associated with different levels of effort is represented by the difference between total revenue and cost.

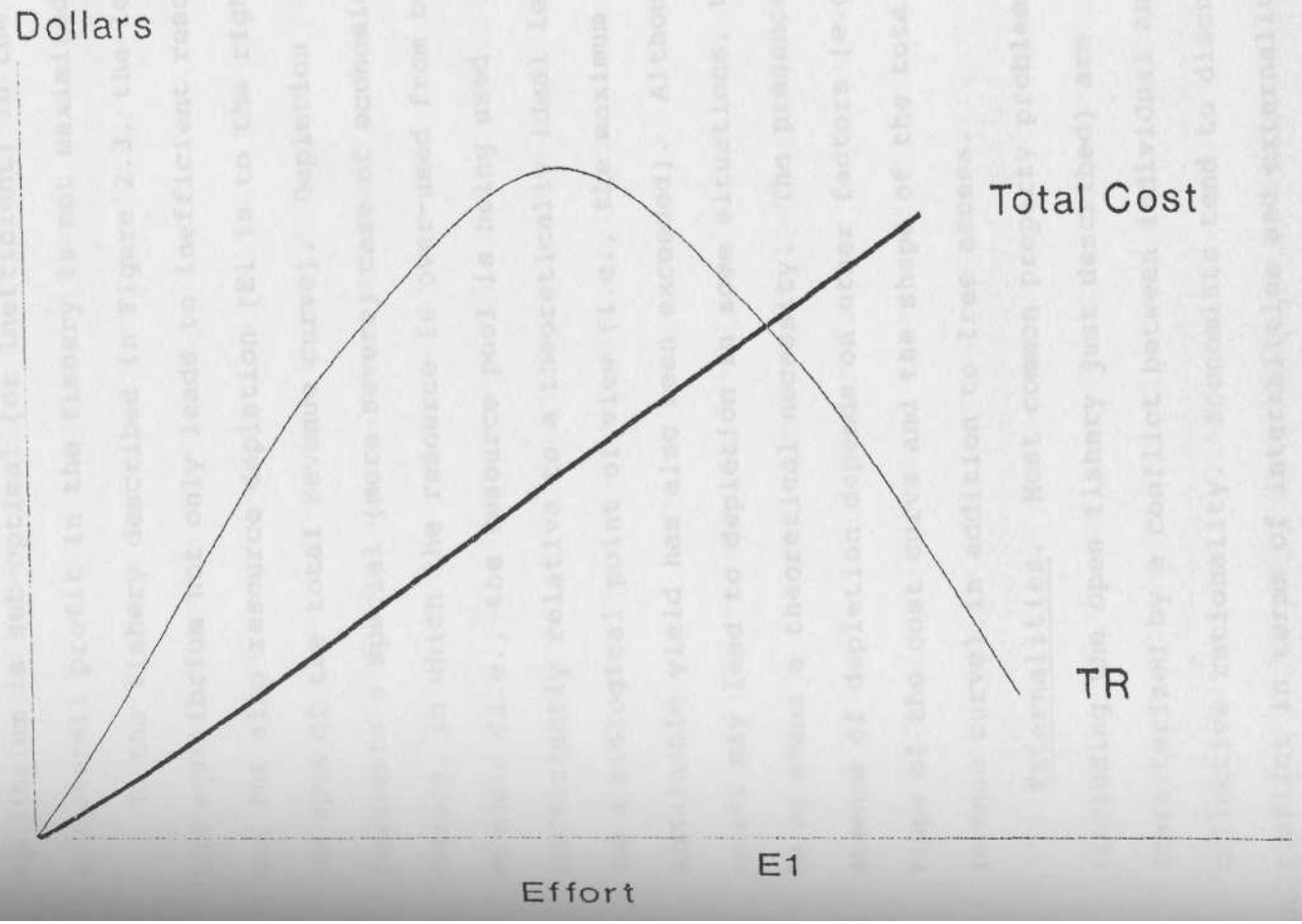
In the closed fishery described in Figure 2.2, a firm will maximize Its profits (and the profits of the fishery as a whole) by setting effort to a level equal to E* (i.e., the level of effort at which the difference between costs and total revenue is at a maximum). From an economic perspective, this optimal equilibrium represents perfectly efficient resource use. Depending on the relation between cost, revenue, and effort, the level of use associated with economic efficiency may or may not be the same as that associated with the maximum sustainable yield.

In the closed fishery, not only does personal profit maximization facilitate efficient resource use, it also

precludes resource depletion. As long as the slope of the cost curve remains positive (a reasonable assumption - it is hard to imagine total costs decreasing with increased effort), the level of effort associated with maximum profit (E~) will never shift to the right of the apex of the total revenue curve. Thus, if overall profits in the fishery are being maximized {i.e., if the resource is being used efficiently), depletion should never occur.

The open fishery (the commons). The annual cost and total revenue functions associated with long-term effort in an open fishery (i.e., a fishery to which any number of firms have access), are presented in Figure 2.3. Note that these curves do not represent the costs and revenues of individual firms, rather they refer to the collective costs and revenues of all firms in the fishery. The basic assumption underlying effort in the open fishery is the same as that in the closed fishery; harvesters will attempt to maximize personal profits. However, unlike in the closed fishery, this strategy does not lead to efficient resource use in the free access situation. In the open fishery, individual harvesters will continue to increase effort (i.e., new harvesters will enter the fishery and/or present harvesters will increase their investments) as long as revenues exceed costs, that is, as long as it is personally profitable to do so. The

Figure 3: Cost and Total Revenue in an Open Fishery



level of effort at which the revenue and cost functions meet (El in Figure 2.3) represents the long-term equilibrium associated with free access. This equilibrium is sub-optimal (or inefficient) in the sense that overall profit in the fishery is not maximized.

In the fishery described in Figure 2.3, the long-term equilibrium not only leads to inefficient resource use, but also resource depletion (El is to the right of the apex of the total revenue curve). Depletion represents a special (more severe) case of economic overuse, in which the resource is over-used from both an economic (i.e., the resource pool is being used inefficiently relative to a theoretically ideal level) and a biological point of view (i.e., the maximum sustainable yield has also been exceeded). Although free access may lead to depletion in some situations, this is by no means a theoretical necessity. The presence or absence of depletion depends on other factors (e.g., the slope of the cost curve and the shape of the total revenue curve) in addition to free access.

Externalities. Most common property problems (including the open fishery just described) are characterized by a conflict between individual and collective rationality. Economists tend to discuss this conflict in terms of internaiities and externalities. Internalities are the costs and benefits that are taken

into account during the decision-making process. Externalities, on the other hand, represent those costs and benefits that are not taken into account. Although externalities can be positive or negative, the significant features of commons dilemmas (i.e., inefficient resource use and resource depletion) are examples of negative externalities.

In the open fishery, decisions about how much effort to invest in the fishery are based on projected personal costs and benefits (i.e., profit maximization). The social repercussions associated with such decisions (i.e., the effect of increased effort on the overall profitability of the fishery and resource depletion) are not generally considered and are, therefore, externalities.

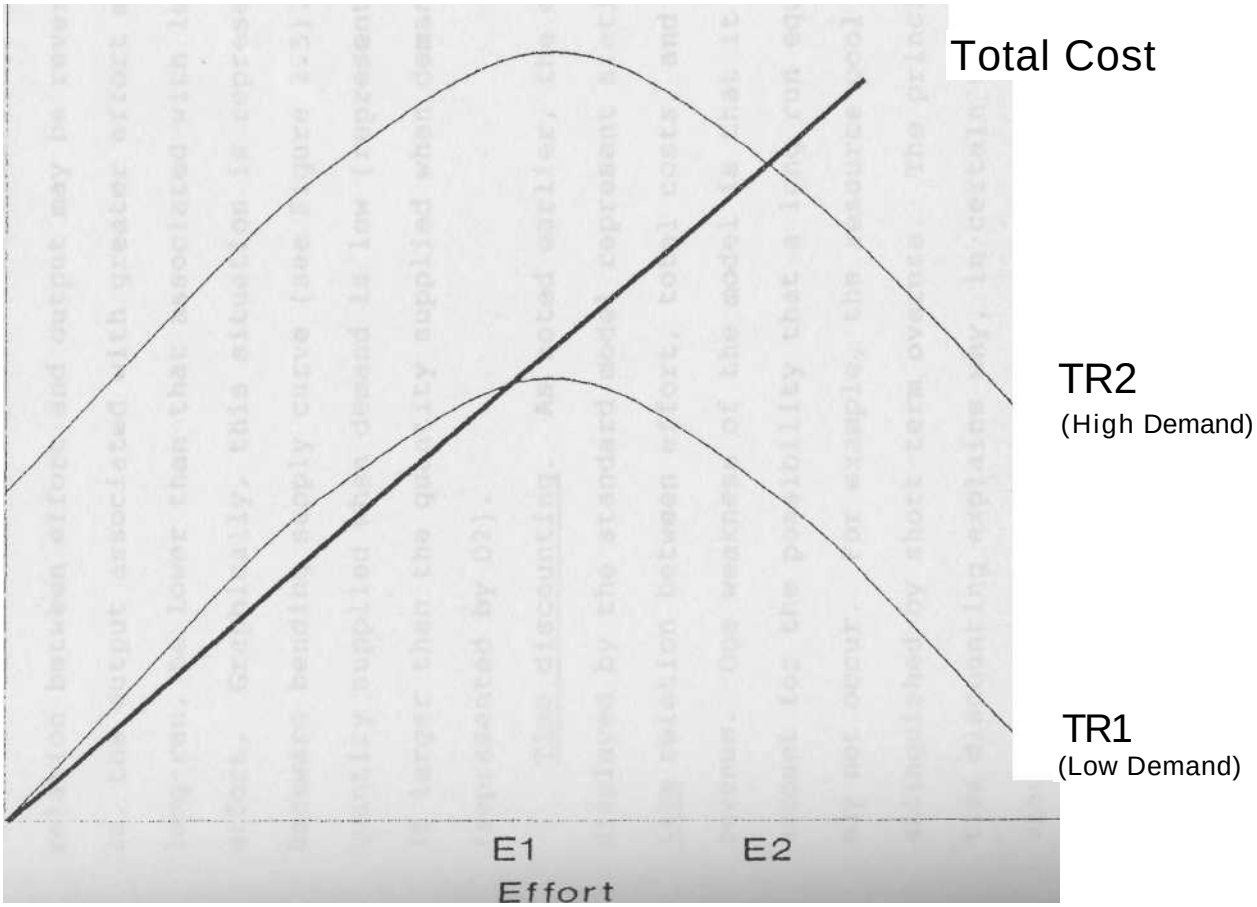
Increased effort may have positive or negative impact on the fishery depending on the magnitude of present effort. If present effort is below the theoretically optimal level (represented by E~ in Figure 2.2) further effort may make the fishery more profitable (i.e., a positive externality will result). However, if present effort is equal to or above the theoretical optimum, increased effort will lead to a reduction in overall profits and, in some cases, resource depletion (i.e., negative externalities will result).

Shifts in demand. Resource depletion may also result from shifts in demand Consider the open fishery described in Figure 2.4. TR1 and TR2 are the total revenue curves associated with low and high demand respectively. When demand is low, the equilibrium solution is represented by EL. El is to the left of the apex of TR1, indicating that even though free entry has resulted in economic inefficiency, resource depletion is not occurring.

If demand is suddenly increased, a number of things happen. First, the price of fish increases, causing the total revenue curve to be shifted upwards (see TR2) and profits to increase. Higher profits encourage further effort of effort in the fishery (e.g., new entries will be attracted and present harvesters will be induced to increase the size of their investments), resulting in a new equilibrium (represented by E2). The new equilibrium is to the right of the apex of TR2, indicating that fish stocks are depleted. Shifts in demand do not cause resource depletion in all free access situations. Important mediating factors include: the magnitude of the increase, the slope of the cost curve, and the shape of the total revenue curve.

A second point regarding depletion also warrants mention. It has been **shown that increased demand tends** to lead to higher **revenues** and **greater effort in the**

Figure 4: Cost and Total Revenue Associated with Two Levels of Demand in an Open Fishery

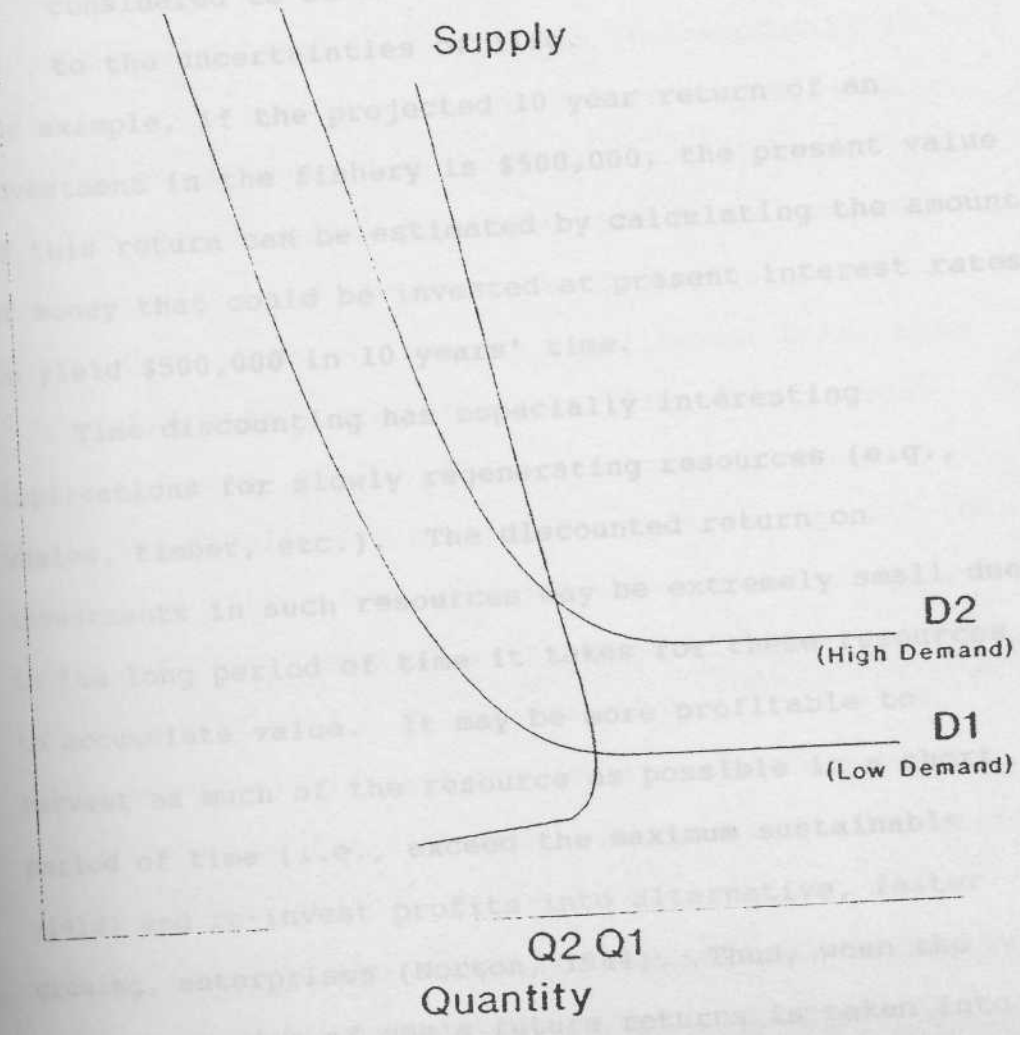


fishery. In most instances, one would expect a strong positive relation between effort and the overall physical output of the fishery (in terms of the number of fish caught). However, if depletion is occurring, the relation between effort and output may be reversed, that is, the output associated with greater effort may, in the long-run, be lower than that associated with lesser effort. Graphically, this situation is represented by a backward bending supply curve (see Figure 2.5). The quantity supplied when demand is low (represented by Dl) is larger than the quantity supplied when demand is high (represented by D2).

Time discounting. As noted earlier, the equilibria displayed by the standard model represent static long-term relation between effort, total costs, and total revenue. One weakness of the model is that it fails to account for the possibility that long run equilibrium may not occur. For example, the resource pool may be extinguished by short-term overuse. The principle of time discounting explains why, in certain situations, short-term extinction may be a profitable strategy in both open and closed fisheries.

Decisions about how much effort to expend in the fishery are usually based on expected future returns (Norton, 1984). The common method for assigning values to future costs and benefits is known as time

Figure 5: Long-run Relation Between Supply and Two Levels of Demand in a Depleted Fishery



discounting. According to Heilbroner, (1980, cited in Taylor, 1988), time discounting is the

> phenomenon of..-the inverted telescope through which humanity looks to the future, estimating the present worth of objects to be enjoyed in the future far below their worth if they could be instantly transferred to the present. This consequent devaluation of the future is considered to be an entirely rational response to the uncertainties of life.

For example, if the projected 10 year return of an investment in the fishery is $500,000, the present value of this return can be estimated by calculating the amount of money that could be invested at present interest rates to yield $500,000 in 10 years' time.

Time discounting has especially interesting implications for slowly regenerating resources (e.g., whales, timber, etc.). The discounted return on investments in such resources may be extremely small due to the long period of time it takes for these resources to accumulate value. It may be more profitable to harvest as much of the resource as possible in a short period of time (i.e., exceed the maximum sustainable yield) and re-invest profits into alternative, faster growing, enterprises (Norton, 1984).

account, extreme resource overuse may represent an economically sensible strategy. Alternative Economic Models

Mathematical models. One of the major advantages of formulating theories in mathematical terms is the reduction of ambiguities and imprecisions characterizing theories that are posed in more qualitative forms. According to Bronowski and Mazlish (I960, cited in Baden & Hardin, 1977), "our confidence in any science is roughly proportional to the amount of mathematics it employs". If this is true, perhaps commons-dilemma research may benefit from a mathematical approach.

The general model just described is an example of a static model; costs, revenues, and effort are all expressed in terms of long-run equilibria. Other more complicated models exist that take time into account (e.g., Anderson, 1977). These are known as dynamic models and usually are presented as phase diagrams. One implication that arises when resource use is considered within a temporal context is the possibility of multiple long-run equilibria. Excess effort in a given time period may result in resource depletion and reduce the profitability of the fishery. In response to declining profits, overall effort in the fishery may decline. However, now that the fishery is depleted, the same level

during the previous time period will result in a smaller harvest during the present period. Thus, there may be two equilibria for the same level of effort. The output associated with each equilibrium is determined by the events occurring during earlier time periods. In some situations, these relations may turn out to be cyclical in nature.

An algebraic model. An algebraic model of the commons has been proposed by Muhsam (1973). Muhsam's model outlines Hardin's commons parable in game theory terminology. The model assumes that (1) the value of each head of cattle will decrease in direct proportion to the number of cattle exceeding the commons' grazing capacity, and (2) the personal benefits associated with adding cattle will always exceed personal costs. The dilemma is conceptualized as a 2-person non-zero sum game (player 1 is an individual herdsman and player 2 is all the other herdsman combined). Each player is limited to two choices: to add or not to add cattle to the pasture. There are two basic scenarios.

(1) If all other herdsmen (player 2) choose not to add cattle to the commons, it is in player l's best

head of cattle player 2 adds beyond the grazing limit, there will be a corresponding decrease in the value of player 1's herd. Therefore, the personal gains associated with adding cattle will offset at least some of the losses caused by the actions of others.

Both scenarios indicate that, regardless of what others do, it is always in the best financial interest of any individual herdsman to increase the size of his herd. Unfortunately, as Hardin and others have noted, if all herdsman adopt this strategy, all may be worse off (depending on the magnitude of the collective costs associated with overgrazing) than if all had not added cattle.

Muhsam's model formally captures some aspects of the standard resource use model outlined earlier (e.g., the conflict between individual and collective rationality). However, a number of simplifying assumptions limit its generalizability to the real world. First, the model assumes the costs associated with overgrazing can be represented as a linear function. Although this assumption is desirable from a mathematical standpoint (calculus is avoided), it reflects a situation that is unlikely to occur in reality. Second, and more importantly, the model assumes that adding cattle will always be personally profitable (i.e., the personal benefits associated with adding cattle will always be

greater than the costs). Thus, as Muhsara readily admits, the model fails to account for situations in which the personal costs associated with adding cattle may exceed benefits (i.e., in the standard economic model of resource use outlined earlier, this situation would be represented levels of effort lying to the right of the intersect between the total cost and total revenue curves). Possible Solutions

The standard economic model suggests that inefficient resource use often stems from an excess of effort in the fishery. Thus, an obvious solution to the problem would seem to involve introducing mechanisms (e.g., government agencies or regulatory commissions) to limit effort. In terms of externalities, agencies and commissions should be created to encourage harvesters to consider the social costs associated with their actions in the fishery. That is, regulations are needed to internalize externalities.

Effort in the fishery can be regulated in a number of ways, three of which will be discussed. Note that these solutions are not mutually exclusive and that an effective resource management program may involve all or combination of those presented here.

(1) Seasonal quotas. In the 1960's, the Inter-American Tropical Tuna Commission (in conjunction with

the fishing nations in North and South America) established an annual catch limit for tuna in response to declining stocks. Records of ail catches were recorded and when the overall quota for the fishery was met the season was closed. The outcome is described by Norton (1984).

> When the quota scheme was initiated in 1967, the size of the tuna fishing fleet was 37,000 tons. Just three years later, in 1970, the fleet had virtually doubled to 65,000 tons. The reason is obvious. Since the total quota of fish was 'up for grabs', the larger the catch per trip and the more trips a fisherman could make before the end of the season, the greater his share of the quota. Therefore, those fishermen who could afford to, bought larger and faster fishing boats, resulting in an over-capitalized industry which harvested the resource in an inefficient manner.

Norton suggests that this problem could have been avoided if tuna commission had introduced as a system of individual quotas, rather than setting one overall quota for the whole fishery. An individual quota system allows each country or firm to determine the most efficient way manage their portion of the resource pool. Although the

introduction of individual quotas may increase fishery efficiency, new headaches are created for those responsible for managing the system. For example, a policing system must be created to ensure individual compliance. Decisions regarding quota size and the accomodation of new entrants into the fishery must be made.

(2) Limiting entry. A second way to improve resource use efficiency involves limiting entry into the fishery. This can be accomplished through a system of licensing where fishing rights (i.e., rights of access to the fishery) are allocated to only a limited number of harvesters. Often quotas and equipment restrictions are attached to licenses and in some cases licenses can be bought and sold. Transferable licensing provides regulatory agencies with an additional mechanism to control effort in the fishery. If fish stocks appear to be declining, the agency can buy up licenses to further reduce effort. Conversely, if stocks are flourishing, more licenses can be released into the market.

A major issue associated with licensing involves the process of allocation. On what basis are licenses initially distributed? For fisheries in which effort is below the optimal level, allocation becomes a non-issue; there will be more than enough licenses to go around. However, if licensing is introduced into an overused

fishery, the number of fishermen may exceed the number licenses an agency wishes to distribute. In such situations "difficult social, legal, economic, and political problems" have be known to arise (Rettig & Ginter, 1980, cited in Royce, 1984).

(3) Limiting technology. The two previous solutions attempt to prevent resource overuse by decreasing effort in the fishery. The final solution aims to decrease effort indirectly by keeping costs high. The introduction of technological innovations (e.g., drift nets, factory ships, etc.) typically leads to a reduction in costs and increased effort in the fishery (i.e., the long-term equilibrium associated with free access shifts to the right as the slope of the cost function becomes less steep). Laws forbidding the use of certain technologies helps ensure that costs will remain high and that effort in the fishery will not increase.

Although placing limits on technology will limit effort in the fishery, it will not solve the problem of inefficient resource use. The equilibrium will still be sub-optimal because harvesters still have free access to the resource pool- However, regulations to limit technology in the fishery can be effectively used to help prevent depletion. If the costs associated with fishing are kept high enough, the equilibrium will remain to the left of the apex of the total revenue curve.

A Developmental Perspective

For the past two decades psychology has been in the midst of a theoretical crisis. Evidence is accumulating from all areas of psychology that, despite literally thousands of experiments, theoretical disputes are rarely resolved. The problem of theoretical indeterminancy has led some psychologists to question the methods presently used to develop theories and to offer alternatives. One such alternative, the developmental methodology, will be examined in this section. The implications for commons-dilemma theory will be highlighted.

According to Tolman and Lemery (1989) theoretical indeterminancy is a problem of abstraction, and more generally a problem of methodology. Materialists assert that any object (i.e., anything we wish to study) is endowed with an infinite number of qualities. Most psychological theories are abstract in the sense that certain aspects of the object or phenomenon of interest become the focus of the theory while other aspects are ignored. The problem with this process is that there is "nothing in the immediate object or in the process of abstraction to tells us what must be abstracted for a proper understanding" (Tolman & Lemery, 1989). Thus, competing theories may appear inconsistent or contradictory, not because one is clearly right and the

other wrong, but because different aspects of the object have been abstracted.

To solve the problem of theoretical indeterminacy, new rules must be developed to guide the abstraction process, that is, a new methodology is needed that captures the concrete essence of an object. According to the materialists, in order to understand anything concretely, we must understand its development. There are three types of development relevant to human characters and processes: phylogenetic, ontogenetic, and historical. Depending *on* the object of study, it may be useful to emphasize one type of development over the others (e.g., a historical approach may be most relevant to an analysis of common property problems). However, for a complete account of an object, all three types of development must be considered.

A brief developmental account of the commons dilemma will be presented. This, by no means, represents a complete theoretical treatment of the subject. However, it may serve as useful starting point for future developments in commons-dilemma theory. Ontogenetic Development

Only one study (Gifford, 1982) has examined the relation between age and quality of resource management in a commons-dilemma situation. Using a sample ranging from 3 to 16 years of age, Gifford found that resource

management efficiency tended to increase with age (although there was a slight, but non significant, decline in efficiency for the 14 to 16 year old groups). Gifford also noted that the cooperation rates in his study were substantially higher than those reported in pilot studies by Edney (1979) that used the same paradigm and 18-20 year old subjects. Although the differences between the two studies may be due to age differences between the two samples, other factors such as regional differences (Edney's study was performed in the United States, whereas Gifford's was performed in Canada), and cohort effects cannot be eliminated as possible alternative explanations.

A substantial collection of studies, using a variety of paradigms other than the replenishable resource paradigm, have also examined the relation between age and cooperation. The results have been mixed. In some studies (e.g., Guttschalat & Frauhauf-Ziegier, 1958; Hirota, 1951; Meister, 1956; Zak, 1968, all cited in Cook & Stingle, 1974), cooperation was found to increase with age. In others, older children were found to be less cooperative (e.g., Ahlgren & Johnson, 1979; Kagan & Kadsen, 1972; Madsen, 1971; Strein, 1986). In a study using multiple measures of cooperation, Stingle and Cook (1985) found that age was positively related to some of the measures but not others. In general, the results

from these studies seem to suggest that (1) cooperation may be a multi-dimensional construct (some aspects of which seem to increase with age, whereas others do not), and (2) the relation between age and cooperation may be moderated by other factors such as culture and the nature of the observed task. Note that the contradictory findings characterizing research examining age and cooperation are entirely consistent with Tolman and Lemery's thesis that objects can be abstracted in a number of different ways.

Little empirical or theoretical work seems to have been conducted to investigate the multi-dimensional character of cooperation. Nor does there seem to have been much of *an* attempt to explain why age is related to improved performance on some tasks that require cooperation but not others. Certainly, a reasonable working hypothesis might be that the relation between age and cooperation is moderated by task difficulty. The resource management task used by Gifford was probably too complex for many of the younger subjects to completely comprehend. Thus, even if the younger subjects were predisposed to be more cooperative this would not be reflected in their performance on the task.

Cross-cultural differences in the cooperation rates of children have been explored extensively in a series of studies by Madsen **and** his associates. Madsen (1971)

found American children to be less cooperative than their Mexican counter-parts in a marble-pulling task. Furthermore, negative relation between age and cooperation was far stronger in the American sample. It has been suggested this result may be related to the strong emphasis placed on individual success in American society (Dworetzky, 1984, pp. 67-69). Studies examining urban-rural differences in cooperation also suggest that cultural factors may play an important role in explaining observed differences in cooperation rates. According to Madsen and Lancy (1981), there is consistent evidence to suggest that children raised in intact cultural groups (e.g., tribes, Kibbutzim, etc.) tend to be more cooperative than those raised in heterogeneous urban settings.

In sum, culture appears to play an important role in the development of cooperative behavior. This suggests that an ontogenetic theory of cooperation (and more specifically the role of cooperation in the commons dilemma) should take culture into account. Furthermore, the role of task difficulty as a potential moderator of the relation between age and cooperation should be explored.

Ontogenetic theories. The ontogenetic theories proposed by Piaget and Kohlberg both deal the maturational aspects of cooperation. Piaget (1965, cited

in Cook and Stingle, 1974) notes that the egocentricity characterizing children up until about 7 years of age is incompatible with cooperation.

> So long as the child does not dissociate his self from the suggestions of the physical world, he cannot cooperate, because in order to cooperate one must be conscious of one's self and be able to situate it with respect to common thought.

In other words, cooperation requires that the child be able to consider the viewpoints of others and coordinate his or her thoughts and actions with them. Thus, according to Piaget, older children should be more cooperative than younger children.

Kohlberg (1963, cited in Cook & Stingle, 1974) has also suggested that cooperation should increase with age. At the pre-moral level (i.e., between the ages of 4 to 10), children tend to be morally opportunistic, that is, they attempt to maximize personal needs and objectives. As children age, "there is a shift from hedonism to a moral position that emphasizes social approval - a 'good boy[1] morality." Kohlberg's conclusion that cooperation should increase with age is based on the questionable assumption that cooperation is highly valued by all societies. In societies that value individual

achievement and a competitive spirit, cooperation may not lead to social approval. Thus, if Kohlberg is to remain true to the basic logic of his argument outlined earlier, he must concede that in some societies cooperation should decrease with age.

Neither of the theories proposed by Piaget and Kohlberg are able to adequately explain the contradictory collection of empirical findings outlined earlier. Both theories are too general and abstract, that is, they fail to address the contextual factors (e.g., culture, task difficulty, etc.) that appear to moderate the relation between maturation and cooperation (although in Kohlberg's theory there seems to be an implicit recognition that culture may be important). New theories are required that take these factors into account. Phyloqenetic Development

Two issues (the ability of some animals to coordinate their activities to minimize the threat to a limited shared resource and aspects of human cognition related maladaptive behavior in commons dilemmas) linking phylogeny to the commons dilemma will be discussed.

Evidence of property rights in wolf communities

Often lower animals are studied in an attempt to identify the origin of human characters. Evidence of cooperation[2] is common within the animal kingdom. The coordinated activities observed in insects (e.g., bees and ants) is

purely instinctive. However, other examples of animal cooperation, such as team hunting displayed by some groups of wolves, wild dogs, and lions, appear to be learned and may be considered part of these animals' culture.

Fredlund (1976) provides an excellent example that suggests that in certain situations wolves may coordinate their activities to minimize the threat to a limited common resource. In a field study of wolves living on the Isle Royale (a large island in Lake Superior), Mech (1966, cited in Fredlund, 1976) observed that most of the packs had loose home ranges in which they hunted. Incursions by other groups were common, however, range conflicts rarely occurred. Mowatt (1963, cited in Fredlund, 1976), studying wolves in the Canadian tundra, found exactly the opposite. Each spring, after hunting caribou for most of the fall and winter, the packs set up individual territories just before the females gave birth to their pups.

Fredlund argues that because not all wolves develop rigid boundary systems, territorially is not an instinctive behavior in wolves. Rather, he asserts, the observed differences in territorially are probably due to situational factors, such as differences in the costs and benefits associated with food capture. The Isle Royale is home to a large moose population upon which the wolves

feed. The moose population is widely distributed, highly mobile, and large enough to provide all the wolves on the island with all the food they require. According to Fredlund, there are few benefits associated with setting up individual territories on the island.

The situation is significantly different in the Canadian North. In the spring, the packs can no longer follow the migrating caribou because the young pups are too weak to travel long distances. With their main source of food eliminated, the wolves turn to the only alternative food source available: mice, lemmings, and ground squirrels. Rodents are not especially mobile and tend to stay close to their dens. The boundaries created by the wolves appear to ensure that the summer's food supply is not over-hunted. According to Fredlund,

> Without boundaries, a larger pack might substantially reduce the number of prey animals available to a neighboring pack in a short time, requiring the members of the smaller pack to travel much farther from the den to find sufficient food i.e., raising the cost of food. Therefore, the cost of survival is reduced by the existence of well defined property boundaries, thus internalizing the external

> cost of over-hunting their land that might occur without boundaries.

Fredlund's analysis suggests that the ability to successfully respond to common property problems may not be a uniquely human quality and that, in some circumstances at least, the solutions employed by animals (e.g., creating territories that are managed by individual groups) appear to be similar to those devised by humans. This is not to say that the processes leading to these solutions are necessarily the same for animals and humans. To my knowledge, there is absolutely no evidence to suggest that animals attempt to solve common property problems (or any problems for that matter) through conscious deliberation. Furthermore, the use of formal institutional mechanisms to regulate property rights seems to be a uniquely human activity.

Cognitive function and the commons dilemma. In order to understand the limitations of our present cognitive faculties, we must recognize their evolutionary origins. According to Ornstein and Ehrlich (1989), throughout our evolutionary history we have had little reason to develop abilities to perceive significant long-term trends.

> When truly long-term changes occurred, early hominids could do little or nothing about it. They could respond to undesirable shifts in

> climate or to a gradual reduction in availability of game or fruit only by migrating or perishing. But such challenges were rare. The environment, both natural and cultural, remained relatively constant for very long periods ...(p. 38).

Thus, whereas quick movements and loud noises immediately command our attention (a clearly adaptive response to the dangers facing our early ancestors), gradual increases in pollution, temperature, and ultra-violet radiation are barely noticed. Ornstein and Ehrlich's thesis has an obvious implication with respect to the commons dilemma; people may defect (e.g., overharvest resources, overgraze cattle, etc.) in the short-run because of a biological insensitivity to long-range trends.

Although it appears that we are not hardwired (i.e., phylogenetically predisposed) to be sensitive to gradual changes in our surroundings, it seems likely that such sensitivity can be enhanced through learning. Ornstein and Ehrlich suggest that

> There is now enough material from studies of human development; cognitive psychology; decision analysis, and the physical, biological, and social sciences in general, to

> develop a new curriculum to deal with the problems of the new world...The key goal of the new curriculum will be to encourage students to think about the nature of their own minds and the limitations on their own thinking, about underlying physical and biological principles that govern the world, and about long-term trends in that world, as early and continuously as possible in their schooling (p. 233).

In addition to being ill-equipped to perceive long-term trends, our brains are also limited in the amount of information that they can process at any one time. Because we lack the capacity to integrate all the information our senses provide, we must selectively attend to only certain parts of our environments while ignoring others. Some aspects of the selective attention process appear to be hardwired. As noted earlier, quick movements and loud noises tend to command our immediate attention. Others (e.g., spending more time looking at the ground after finding a $50 bill on the sidewalk) are clearly learned.

How is our limited ability to process information related to our behavior in commons dilemmas? Dawes (1980) has suggested that the complexity of social dilemmas make it difficult for us to immediately

comprehend all the implications of our choices. Consequently, we selectively attend to the most salient aspects of the situation. As noted earlier (cf. limited processing theory), the payoffs associated with cooperation and defection appear to be especially salient cues in a money-centered society. Thus, in situations where the payoffs for defection are larger than those for cooperation, high rates of defection are to be expected. Note, however, that most commons dilemmas also involve a temporal component (cf. social trap theory). Although immediate payoffs favour defection, in the long-term, full-scale cooperation may represent a more prosperous option. From a phyiocenetic perspective, Ornstein and Ehrlich's thesis that we are genetically predisposed to attend to immediate rather than future consequences may explain why individuals often forego long-term benefits in favour of immediate gratification. Historical Development

Property systems tend to change over time and often vary from society to another. Historical research is necessary to determine which factors underlie change and the dominion of certain systems in different parts of the world. A brief discussion of the function of property systems (the bulk of which is based on Waldron, 1988) will be followed by a proposed framework for conducting

historical research. An example of the historical approach will also be presented.

According to Waldron, a property system is a system of rules governing access to and control over material resources (i.e., objects that satisfy some human want or need). Most discussions of property are based on the presupposition of scarcity. If there is no scarcity, allocation rules are unnecessary; each individual may use as much of the resource as he or she pleases. However, in situations where the demand for a resource exceeds its supply, serious disagreements regarding allocation may emerge. Waldron summarizes the problem as follows:

> ...the problem of allocation arises in any society which regards the avoidance of serious conflict as a matter of any importance. This is the problem of determining peacefully and reasonably predictably who is to have access to which resources for what purposes and when...property rules are ways of solving that problem (p. 32).

Property systems always operate within a context of background constraints (i.e., rules and laws that specify how or under which conditions certain resources can and cannot be used). Thus, property rules (i.e., rules that specify who can use certain resources and when they can

use them) become relevant only after it has been established that a particular resource can be used in a particular manner. For example, in the case of a local fishing pond, property rules would specify who is entitled to fish in the pond and during what time periods this activity may occur. Rules pertaining to the type of gear that can be used are background constraints, not property rules. Both types of rules seem relevant to understanding resource use in any particular context.

Types of property systems. Property systems can be divided into three general types: common, private, and collective property.

(1) Common property. In common property systems, allocation rules are organized around the notion that resources are not owned or controlled by anyone in particular, but are available for use by all members of society. Public parks represent one example of resources that are typically managed according to this type of system.

A number of classical philosophers have used the notion of common property to describe the original (i.e., in the "State of Nature") relation between men and resources. However, as Benn (196 7) has noted, many of these writers did not conceive of common property as an allocation system per se, but rather as the absence of a system. This distinction need not concern us here;

regardless of one's definition of system, it seems likely that most resources were originally held in common. As certain resources became scarce, modifications to the existing set of arrangements may have been introduced to limit conflict. For example, group members may have negotiated agreements to limit the size of their harvest?. In situations where modifications to the existing property system were ineffective or impractical, new allocation systems (i.e., private property or collective property systems) may have emerged.

(2) Collective property. In collective property systems, resource allocation decisions are made by a central authority,, based en the collective interests of society. According to Waldron,

> in principle, material resources are answerable to the needs and purposes of society as a whole, whatever they are and however they are determined, rather than to the needs and purposes of particular individuals considered on their own. No individual has such an intimate association with any object that he can make decisions about its use without reference to the interests of the collective (p. 40).

Critics of collective property systems are quick to point out the difficulties associated with determining what constitutes the collective interest. Are considerations of human dignity and happiness to be given priority over those of economic growth? Is national security more important than food production?

(3) Private property. In private property systems, allocation rules are organized around the notion that resources can be divided into discrete parcels and assigned to specific individuals. Within the legal constraints of society, owners are permitted to use or distribute the resource in any matter in which they choose.

Arguments in favour of private property seem to be of two basic types: utilitarian, and naturalistic. Utilitarian arguments emphasize that the total happiness or well-being of society will be greater under a private property system than under collective or common property systems. For example, western economists have argued that private property is a necessary prerequisite for economic efficiency. The economic model of resource use presented earlier in this chapter and recent developments in Eastern Europe indicate that these arguments may be correct. Naturalist philosophers (e.g., John Locke) suggest that private property is a fundamental (i.e., natural or God given) right of mankind.

Two points are worth noting about property systems. First, few (if any) societies in the real world are characterized by only one type of property system; in most cases, all three systems are present, although one type is usually dominant. According to Waldron, in a given society, the relative strength of competing political factions can be judged by the pervasiveness of each of the three property systems. For example, in the Soviet Union although there has been some movement towards privatization in recent years, a collective property system remains prevalent.

The medley of property systems characterizing most societies is at least partially attributable to resource characteristics. Certain resources appear to be more amenable to particular allocation system? than others. For example, air and sunlight (and possibly parks) are probably best treated as common property, whereas resources, such as clothes and toothbrushes seem especially suited for a private property system. A collective property system may be most appropriate for allocating resources such as roadways and military hardware.

A second point worth mentioning is that the property systems outlined here represent abstract concepts. The specific concrete manifestations of each system will vary situationally. For example, a private property system

may be characterized by transferable or non-transferable rights. The specific liberties, liabilities, and duties (i.e., background constraints on actions) associated with private ownership may also vary depending on the nature of the resource (the constraints associated with owning land and owning a car are very different) and the nature of the owner (corporate ownership and individual ownership are constrained by a separate set of laws).

A framework for historical research. It has been established that (1) property systems serve to solve the problems associated with the allocation of scarce resources, (2) a number of different types of property systems exist, and (3) the specific manifestation of each type of system may vary depending on a variety of situational factors (e.g., resource and user characteristics). From a developmental perspective, we are interested in determining why certain property systems develop or are adopted in some situations but not others. Furthermore, attempts should also be made to account for specific variations found in particular systems.

Perhaps the most appropriate way to resolve these issues is through archival research. A quantitative approach similar to that used in this review (cf. methods chapter), might prove to be especially useful. For example, historical accounts of shifts and/or

modifications in property right systems could be reviewed. For each historical case, researchers would code the type of system adopted, specific characteristics of the new system, and other hypothetically relevant contextual factors (e.g., culture, group size, communication, resource type, etc.). Models of emerging property right systems could be constructed and hypothesized relations between variables could be tested using standard quantitative methods.

Although, no quantitative archival studies investigating property systems appear to have been conducted, a number of qualitative analyses examining the relation between economic factors and the emergence of private property rights were identified (e.g., Anderson & Hill, 1977; Demsetz, 1967; Umbeck, 1977). The Demsetz article (the earliest and arguably most influential of these analyses) will be examined in detail.

Property rights and American Indians. According to Demsetz, the main function of property rights is the internalization of the beneficial and harmful effects associated with the development of new technologies and markets. In situations where the gains of internalization outweigh the costs of internalization, property rights are predicted to emerge. Although Derasetz acknowledges that the type of property system that actually emerges is largely tied to a "community's

tastes in this regard", the bulk of his discussion focuses on transitions from common property to private property systems in American Indian communities.

In contrast to their counterparts residing on the plains of the American Southwest, native aboriginals inhabiting the Labrador peninsula in Northern Canada have a strong tradition of private property rights. Citing the anthropological work of Eleanor Leacock, Demsetz suggests that these observed differences are linked to the beginning of the fur trade. Historical accounts suggest that prior to the fur trade, the Labrador Indians managed fur-bearing animals as a common resource; each hunter took as much as he needed for food and family use. Because the demand for furs was relatively low, the externalities associated with unregulated hunting (e.g., the costs to future hunters in terms of resource availability) were relatively insignificant. The arrival of the fur trade prompted a dramatic increase in the value of furs. Indian hunting activity rose markedly as did the significance of the externalities associated with the existing common property system (because common property systems provide little impetus to conserve resources - the benefits associated with conservation are not concentrated on the individuals displaying restraint, but are spread across all group members - overharvesting

is likely to occur in situations characterized by high demand).

On Demsetz's view, the emergence of serious externalities is not enough in itself to facilitate a shift in property systems; the benefits associated with the alternative system must exceed the costs of implementing and operating the system. In the case of the Labrador Indians, the benefits of private property are obvious; resource management efficiency should increase (i.e., there should be a reduction in overhunting) since all the costs associated with mismanagement will be directly bourne by the territory owner. Demsetz also notes that the forest habitat of the Labrador aboriginals was favourably suited for a private property system. Most of the animals trapped by the Indians inhabit relatively small territories, thus the costs of preventing the movement of animals from one territory to another was small.

What prevented the Labrador Indians from retaining a common property system and negotiating a settlement limiting resource use?. According to Demsetz, the transaction costs associated with negotiating such a settlement would be prohibitive (since in order to be effective, all hunters would have to unanimously agree to the settlements terms). In a private property system, disputes regarding externalities will not typically

involve all group members. Thus, the transaction costs associated with settling such disputes are expected to be substantially lower than in the common property situation.

Why did private property systems fail to emerge in Indian bands occupying the southwestern United States? Demsetz provides two explanations.

> The first of these is that there were no plains animals of commercial importance comparable to the fur-bearing animals of the forest, at least not until cattle arrived with Europeans. The second factor is that animals of the plains are primarily grazing species whose habit is to wander over wide tracts of land. The value of establishing boundaries to a private hunting territories is thus reduced by the relatively high cost of preventing the animals from moving to adjacent parcels (p. 353).

Thus, in the case of the plains Indians, there was no market change reducing the effectiveness of the established common property system. Furthermore, even if such a change had taken place, the costs associated with maintaining individual territories may have prevented the adoption of a private property system.

In sum, it appears that different aspects of common property problems are amenable to ontogenetic,

phylogenetic. or historical interpretations. This suggests that a developmental methodology may provide a useful theoretical framework for organizing present knowledge and guiding future corntions-dilemma research.

Footnotes

[1]Only an abbreviated discussion of equity theory is presented here. For a more complete treatment of this theory refer to Walster, Berscheid, and Walster,(1973).

^Cooperation, as it is used here, refers to coordinated group action. No consciousness of purpose is implied.

CHAPTER 3 Meta-Analysis

Introduction and History

Meta-analyais has been defined by Landman and Dawes (1982) as the "statistical averaging of the standardized results of a large number of studies." This definition is deficient in at least two respects. First, although meta-analyses are often performed on large numbers of studies, at least some aspects of the procedure can be applied to as few as two studies (Rosenthal, 1984). Second, although meta-anaiysis is commonly used to summarize primary research results, it can also perform at least two other important functions: (1) it may be used to identify methodological factors (e.g., experimental design., operationalizations of variables, etc.) that may moderate an observed relationship between two variables, and (2) it can be used to test new hypotheses by analyzing the aggregated data from primary research (Rosenthal, 1984). It is not uncommon for a meta-analytic study to perform all three functions.

Methods for combining probabilities have been available for a relatively long period of time (e.g., see Fisher, 1932; Pearson, 1933). Rosenthal used procedures similar to those described by Fisher and Pearson in his famous work on experimenter effects in the 1960s. However, it was not until the late 1970s that the use of

meta-analysis became widespread among psychologists. In the last decade, hundreds of meta-analyses have been performed on psychological research. Advantages of Meta-analysis

Primary researchers and reviewers have similar tasks. Both attempt to formulate general conclusions based on the evaluation of a collection of data points from a sample population (Cooper, 1984). In primary research, each data point is usually associated with a single subject or group of subjects, whereas in a review each data point corresponds to the results from a particular study. Despite having similar goals, the standard methods used by primary researchers and reviewers often differ dramatically. For example, primary researchers typically evaluate their data quantitatively, using statistical procedures to test their hypotheses. On the other hand, reviewers traditionally adopt a qualitative or narrative approach. Unlike primary research, there is no standard methodological protocol that has been adopted for performing reviews (although the procedures outlined by Cooper, 1984 deserve consideration for such a distinction). As a consequence, many reviews tend to be unsystematic, noncomprehensive, idiosyncratic, and of questionable validity (Cooper, 1984).

Meta-analysis represents a potentially superior alternative to traditional review methods for a number of reasons. First, in order to perform a meta-analysis, specific information must be collected from each research report. Quantitative reviewers are forced to proceed more systematically and thoroughly than traditional reviewers. Second, quantitative procedures allow reviewers to reliably calculate cumulative probabilities and effect sizes for a group of studies. Traditional review methods do not. Third, meta-analyses produce more objective summaries of primary research than qualitative methods (Landman & Dawes,. 1982). A standard statistical protocol forces quantitative reviewers to make "explicit detailed decisions which might be left unmentioned in traditional reviews" (Strube & Hartmann, 1983; cited in Brown, 1987). Fourth, traditional reviews "suffer a very considerable loss of power relative to meta-anaiyticai methods (Cooper & Rosenthal, 1980; cited in Rosenthal, 1984)." Cooper and Rosenthal found that reviewers are more likely to overlook a "real relationship" between two variables (i.e., make a type 2 error) when using traditional review methods than when using quantitative procedures. Finally, given the massive amount of research information available to present reviewers (both in terms of numbers of studies published, and increased ease of access to these studies through computerized

literature searches), traditional techniques of verbally describing each study in the review may be, in some cases, no longer feasible (Cooper, 1984). Criticisms of Meta-analysis

A variety of criticisms have been directed towards meta-analytical procedures. Rosenthal (1984) sent a meta-analytical manuscript on interpersonal expectancy effects to 36 colleagues and asked for their comments. The respondents' criticisms were classified into six general categories which are described in the following paragraphs.

The sampling bias (file drawer) problem. Some critics of meta-analysis argue that some studies are far more likely to be retrieved and analyses than others. More specifically, these critics predict the systematic omission of unpublished studies. According to Brown (1987), "there is a well documented and reliable finding...that research that does not reach statistical significance has a reduced chance of being published." If the studies included in an analysis are not representative of the total number of studies conducted on a particular research topic, the validity of the review outcome must be questioned. Note that this criticism is not restricted to meta-analyses, traditional reviews also suffer from the sampling bias problem.

Although no definitive solution to the sampling bias problem has been proposed (besides, of course, conducting a completely exhaustive literature search including published articles, unpublished and unwritten manuscripts, dissertations, theses, etc.), both Cooper (1984) and Rosenthal (1984) suggest that the calculation of a "Fail-safe N" provides a useful estimate of the resistance of a review outcome to unretrieved null results. Cooper (1984) writes, "The Fail-safe N answers the question, "How many comparisons totaling to a null hypothesis confirmation...would have to be added to the results of the retrieved comparisons in order to change the conclusion that a relation exists?" For limitations of this procedure, see Cooper (1984, pp. 92-94). Loss of information. Some suggest that by summarizing a relation between two variables with a single number (e.g., an overall effect size), reviewers may overlook the role played by potential moderators. This criticism is based on the misconception that meta-analysis is exclusively a summarizing procedure. As mentioned earlier, one of the major functions of meta-analysis is identifying potential moderators. For example, one can perform a homogeneity analysis on the effect sizes from a collection of studies. If this analysis is significant (i.e., the variance in effect sizes across studies is greater than would be expected by

chance) there is good reason to suspect that methodological factors may be moderating the relation between the variables of interest. Traditional statistical methods (e.g., ANOVA, t-tests, correlation, etc.) can be used to identify specific moderators. More about this will be discussed in Chapter 4.

Problems of Heterogeneity. Two types of criticisms regarding heterogeneity were common. The first concerned heterogeneity of method and the second focused on heterogeneity of quality.

(a) Heterogeneity of method. Meta-analysis involves the aggregation of a number of conceptually, but not necessarily methodologically, similar studies. For example, all studies included in the quantitative section of this thesis involve tasks in which participants can either cooperate or defect. However, the specific operationalizations of the independent and dependent variables, the statistical procedures used, etc., will tend to vary across studies. The question arises, "Is it appropriate to combine studies characterized by methodological differences?"

According to Rosenthal (1984), the answer is yes! In fact, heterogeneity of method may be more of a blessing than a problem. A strong overall effect characterized by little variability increases our confidence in the generalizability of that effect.

Furthermore, a highly variable overall effect size can be very informative, suggesting that methodological factors may be moderating the observed effect- Cooper(1984) suggests that reviewers code a wide range of methodological factors associated with each study. This ensures that potential moderators can be identified easily using traditional statistical methods to compare the average effect size from studies characterized by a specific methodological feature with the average effect size from studies not characterized by the feature.

(b) Heterogeneity of quality. Some critics suggest that the inclusion of low-quality studies in a meta-analysis will result in a distorted representation of the true effect. They argue that only high-quality studies should be included in the analysis. Unfortunately, research quality seems to be difficult to objectively evaluate. Cooper (1984, pp. 63-64) reports that the results from studies on evaluator agreement about research quality are "somewhat disheartening", with reported intraclass correlations (for agreement on publication decisions) ranging from +.54 to +.19.

Both Brown (1987) and Rosenthal (1984) recommend that studies be weighted according to quality. Studies that are judged to be of high quality should be given larger weights than those judged to be of lesser quality. However, having noted the problems associated with

evaluating research quality. Cooper (1984, pp. 66-71} suggests that all studies receive equal weighting and that quality-related factors (i.e., methodological flaws threatening the validity of a study's results) be coded and later evaluated as potential moderators.

Violations of independence assumptions. Most quantitative syntheses are based on the assumption that all data points included in an analysis are independent. Often individual studies include more than one test of the same hypothesis (e.g., there may be multiple independent or dependent variables supposedly measuring the same general construct). If the results from each hypothesis test are treated as separate data points in the analysis, independence assumptions will be violated. To overcome this problem, Brown (1987) suggests that each hypothesis test be weighted so that each study contributes only one data point to the overall analysis. For example, if a study contains three tests of the same hypothesis, each test would be given a weight of 1/3. Studies containing only one hypothesis test would be given a weight of one.

Some critics point out that even if each hypothesis test is weighted, the data included in many meta-analyses will still violate independence assumptions. For example, studies conducted by the same researcher (or research laboratory) are often characterized by similar

experimental designs and subject samples. If a number of studies by the same researcher are included in the analysis the data points will not be perfectly independent.

One way to overcome this problem is to use the laboratory or researcher as the unit of analysis in one's review (Cooper, 1984). That is, studies are weighted so that the cumulative work of each laboratory or researcher contributes only one data point to the overall analysis. The major problem with this solution is that the number of potential data points for the analysis is substantially decreased, resulting in a corresponding decrease in power.

There is some evidence to suggest that the "researcher as the unit of analysis solution" may not be required. Rosenthal (1984) reports that he ran two concurrent meta-analyses on the same sets of interpersonal expectancy data. One analysis used the laboratory as the unit of analysis (i.e., studies were weighted so that each laboratory contributed only one data point to the overall analysis) and the other used the study as the unit of analysis (i.e., hypothesis tests were weighted so that each study contributed only one data point to the overall analysis). Regarding his results, Rosenthal writes, "The only noticeable difference in Z's is for the research area in which there

were substantially more studies (n = 57) than there were laboratories (n = 20). Even there, however, it seems unlikely that we would have drawn very different conclusions from these two methods of analysis."

Exaggeration of significance levels. Some critics argue that as the number of studies (N) in one's analysis increases so does the probability of rejecting the null hypothesis. Rosenthal (1984) points out that this is only true if the null hypothesis is false, in which case we would want to reject the null anyway. Adding studies to an analysis merely increases the power of finding a relation, given that one exists. The overall effect size (the size of the relation between two variables) is not influenced by the number of studies included in an analysis.

The practical importance of estimated effect size. Although most social science researchers are aware of the benefits of including some measure of effect size with their results, this practice is still somewhat uncommon. Perhaps this stems from the fact that most psychological studies tend to yield small effect sizes.

Rosnow and Rosenthal (1988) argue that traditional effect size estimates (such as r^2) consistently underestimate the practical size of observed effects, they suggest that r (the Pearson product moment correlation coefficient) be adopted as the standard

measure of effect size. The utility of adopting r as a measure of effect size is illustrated by what Rosnow and Rosenthal call the Binomial effect-size display (BESD). The BESD is a symmetric 2 X 2 contingency table, with the two rows corresponding the experimental conditions (e.g., a group size of three versus a group size of nine) and the two columns corresponding to a dichotomous division of the dependent measure (e.g., in the case of commons-dilemma research, cooperation versus no cooperation). The values in each cell are frequencies. Rosnow and Rosenthal illustrate that the differences in cooperation rates between subjects in the two experimental conditions is identical to r. For example, r - +.3 corresponds to a difference in cooperation rate of .3 (a 30% increase), a relation of high practical significance even though over 90% of the variance in cooperation is left unexplained. In sum, a number of criticisms have been directed towards meta-analytic methods. For the most part, these criticisms seem to have been adequately addressed and meta-analysis must be considered a sensible alternative to traditional review methods.

CHAPTER 4

Methods

Literature Search

Studies included in this review were located through the following methods.

a. Psychological Abstracts (PSYCHLIT on CD Rom, 1973 to 1989; DIALOG, 1986 to present) and Sociological Abstracts (SOCIOFILE on CD Rom, 1977 to 1989). Keywords included: common* dilemma*, N-person, social dilemma*, resource dilemma*, decomposed prisoner's dilemma*,and social trap*.

b. Reference tracking. The reference sections of all collected articles were scanned for relevant studies that were missed by our computer searches.

c. Finally, written raguests for recent studies (unpublished manuscripts, articles in press, conference papers, etc) were sent to leading commons-dilemma researchers. These included: Dr. Paul Bell (University of Colorado), Dr. Marilynn Brewer (University of California, Los Angeles), Dr. David Messick (University of California, Santa Barbara), and Dr. Charles Samuelson (Texas A & M University).

Criteria for Inclusion

All studies included in the quantitative section of the thesis dealt with social dilemma situations, that is, situations characterized by two essential properties:

(a) each individual in a group receives a lower payoff for public interest choices (cooperation) than for self-interest choices (defection) regardless of other group members' choices, and (b) the payoffs associated with universal cooperation are higher than the payoffs associated with universal defection.

Two specific types of social dilemmas were examined[1]: commons dilemmas and N-person prisoner's dilemmas (NPDs). Commons dilemmas are characterized by a conflict between individual and collective interests with respect to the management of a limited shared resource. Most commons-dilemma studies included in this review conformed to the replenishable resource paradigm outlined earlier. The NPD is a general research paradigm used by social psychologists to study cooperation in groups. Although NPDs do not share all the characteristics of the replenishable resource paradigm, they are conceptually similar and cross-paradigm generalizations are common (Dawes, 1980; Edney, 1981; Messick & Brewer, 1983). NPD studies were included in this review for two reasons: (1) to allow us to determine whether cross-paradigm generalizations are in fact justified, and (2) given that such generalizations are justified, to substantially increase the number of studies included in review, which in turn will increase our confidence in the cumulative

probabilities and effect sizes generated by the meta-analysis.

Most initial inclusion decisions were based on reading the abstracts provided by Psychlit, Sociofile, and Dialog. In cases where studies were discovered by reference tracking, the full report was scanned. Unit of Analysis

To minimize violations of data independence, a shifting unit of analysis approach (Cooper, 1984, pp. 76-77) was adopted for this review. Studies including multiple tests of the same hypothesis were weighted so chat each study contributed only one data point to the calculation of cumulative probabilities and effect sizes. In situations where multiple experiments (i.e., experiments that used independent samples) were included in one research report, each experiment was considered to be a separate study. When examining potential moderators (i.e., methodological characteristics of studies that may have systematically influenced the outcome of a study), each hypothesis test was treated separately. This ensures that no information is lost when methodological comparisons are made and increases the power of the moderator search.

An example may help clarify how the "shifting units" approach is used. Suppose we have a research report that includes two tests of the hypothesis "variable X is

positively related to variable Y." One test is performed on a female sample and the other on a male sample. Assuming both samples experienced the same experimental treatment(s), the results from each test will not be completely independent. To minimize the independence violation, each hypothesis test will be weighted so that the study will contribute only one data point to the overall meta-analysis (i.e., each hypothesis test will be given a weight of 1/2). However, if for some reason the reviewer suspects that the relation between variable X and variable Y is moderated by gender (e.g., if the effect sizes between studies are highly variable, and the reviewer noticed that some studies had all female samples whereas others had all male samples). He or she would treat the effect size associated with each hypothesis test involving gender as a separate data point when testing for significant moderators. Potential Moderators

A number of methodological characteristics of primary research studies were coded as potential moderators of study outcomes. These characteristics were divided into six general categories. (1) General characteristics of the study

a. Resource type (e.g., points, energy, fish, etc.).
b. Paradigm (replenishable resource versus NPD)
c. Was harvesting anonymous or public?

d. Was communication permitted among group members?

e. Were subjects informed about the ecological relevance of their task?

f. Unit of analysis (individual versus group).

g. Were the number of rounds or iterations known by the subjects.

h. Were subjects given feedback about other group members actions from the previous trial (e.g., number of cooperative responses, state of the resource pool, etc.)

i. Whether the regeneration rate of the resource pool was constant or variable.

j. A rough estimate of the value of the payoffs (the product of value of the resource and the initial number of resource units in the pool, divided by the number of members in a group).[2]

k. Group size.

1. Other.

(2) Independent variable manipulations (i.e., the manner in which the independent variables were operationalized in the study).

(3) Dependent variable measures (e.g., proportion of cooperative responses, total group harvest, mean individual harvest, number of rounds played before the resource pool was depleted, etc.).

(4) Factors that influence generalizabiiity

a. Sample characteristics (size, gender, population).

b. Location of study (country, university).

(5) Statistics

a. Test used.

b. Between or within subjects design.

c. The number of other factors included in the same analysis.

(6) Other miscellaneous factors that threaten the validity of the study's outcome.

The codesheet used in this study is presented in Appendix A.

Statistical Conventions

A series of meta-analyses were performed to examine the relation between a number of factors and cooperation in commons dilemmas and NPDs. Each factor was classified into one of three general categories:

(1) Resource characteristics

a. whole versus subdivided resources

b. resource use (feedback that indicates over, under, or optimal use of the resource pool)

c. pool size

d. cause of resource abundance or scarcity

(2) Participant characteristics

a. gender

b. personality

c. previous experience with social dilemmas

d. social (individual versus group) identity

e. social (cooperative versus competitive) values

f. trust

g. variance in others' harvests

h. age

i. perceived attitude similarity of group members j. culture (3) Rules of the game

a. communication among group members

b. decision framing

c. forced equal resource allocation

d. feedback about others' choices or harvests

e. moral suasion

f. payoffs

g. public versus private choice

h. resource pool feedback

i. group size

j. providing dilemma related information and strategies

k. presence of reward and punishment.

1. access to resource

m. perceived task difficulty

n. number of rounds played on time to reflect about one's choice

Each meta-analysis proceeded according to the following steps.

(1) Effect size estimates (r) were calculated for each hypothesis test using the formulas suggested by Rosenthal (1984, p. 25). Wherever possible these estimates were based on F-values and df error terms (formula 2.17). However, if this information was not available, r was estimated from the Z-score associated with the overall p_-level of the test and study size (formula 2.18). Studies that reported significant results but lacked the appropriate statistical information necessary to calculate effect sizes by one of these methods were dropped from the analyses. Studies that reported null results but included no test statistics were assigned a probability of .5 (and an effect size of 0) following the conventions suggested by Cooper (1984) and Rosenthal (1984) .

(2) An overall probability for the combined studies was calculated using Stouffer's "adding Z/s" method. This method entails (a) calculating the probability associated with a given F value, (b) looking up the 2^-score associated with the exact probability, (c) adding up the Z-scores from each study in the analyses (counter-directional results are represented as negative Z_-scores), (d) dividing the summed Z-scores **by** the **square** root of the number of studies in the analyses, and (e)

looking up the probability associated with the combined Z. The resulting probability indicates the likelihood that the observed results could have occurred given the null hypothesis (i.e., that there was no relationship between X and Y) was true for each of original studies.

If a study contained more than one test of the same hypothesis, each hypothesis test was weighted so that the study contributed only one data point to the overall analysis. Studies were not weighted according to quality. According to Cooper (1984, pp. 63-67), quality weightings introduce unnecessary subjectivity into the analysis and represent a serious threat to a review's validity.

Wherever possible, focused hypothesis tests (i.e., those involving comparisons between two groups or a priori comparisons) were included in the analysis rather than unfocused tests (e.g., an omnibus F calculated for more than two groups). Unfocused tests indicate that an overall significant difference exists between different levels of a particular independent variable. However, they do not provide information about which levels significantly differ from which. Consequently, the information derived from such tests is usually ambiguous and uninformative (Rosnow & Rosenthal, 1988).

(3) A Fail-safe N was calculated for a significance level of $p < .05$ using the conventions described by Cooper

(1984, pp. 92-93). This measure represents a response to sampling bias criticism often directed at meta-analytical research and indicates the number of null result findings that would be needed to raise the combined probability of a set of studies to above $p < .05$- According to Rosenthal (1979, cited in Cooper, 1984) one can be confident about the resistance of a finding if the Fail-safe N is greater than 5 times the number of retrieved studies plus 10-

(3) An overall statistical effect size was calculated for the combined studies. Effect size is a measure of the strength of relation between two variables. The Pearson correlation coefficient (r) was adopted as measure of effect size for this study.

The calculation of the overall effect size involved the following steps: (a) an effect size (r) was calculated for each study in the analysis using the conventions suggested by Rosenthal (1984, p.25), (b) each r was standardized into a Fisher Zr, (c) a mean Z_r was calculated by summing the individual Zr's from all studies and dividing this sum by the number of studies in the analysis, (d) from a Fisher Zr table an overall r (the statistical effect size for the combined studies) corresponding to the mean Zr was found.

Once again, that if a study contained more than one test of the same hypothesis, each hypothesis test in that

study was weighted in order that the study contributed only one data point (effect size) to the overall analyses. (4) A homogeneity analysis {see Rosenthal, 1984, pp. 77-78) was performed to determine whether the variance in effect sizes across studies was significantly different than that expected from sampling error. A significant result indicates that the observed variability in effect sizes is probably not due to chance alone. In other words, other factors may moderate the relation between the two variables studied.

If the homogeneity analysis was significant, a search for possible moderators was performed. When the methodological features could be easily broken down into dichotomous subgroups (e.g., communication versus no communication), correlations were computed between the potential moderator and effect size. A significant correlation suggests that the methodological feature is an important moderator.[3] In cases where the potential moderator was broken down into more than two categories, a one-way analysis of variance was performed with the potential moderator as the independent variable and effect size as the dependent variable. If the ANOVA was significant, Scheffe's range test was employed to determine which moderator subgroup means significantly differed from each other at the -10 level. If the

homogeneity analysis was not significant, no further analyses (i.e., search for moderators) were performed. Finally, a second set combined probabilities were computed to determine whether the relation in question held for each significant moderator subgroup.

Footnotes

[1]A substantial literature also exists for a third type of social dilemma known as the public goods dilemma. Public goods studies will not be included in this review, however, an extensive treatment of this topic is presented by Strobe and Frey (1982).

[2]In a large proportion of the studies reviewed, it was impossible to apply a precise dollar amount to each resource unit (e.g., in cases where resource units were traded for school supplies, lottery tickets, or class credit) . Consequently, this variable was dropped from all further analyses.

[3]This procedure has been previously used by Findley and Cooper (1983).

CHAPTER 5

Results General Description of Study Characteristics

In total, 71 studies (46 from PSYCLIT and DIALOG, 20 from reference tracking, and 5 from the authors themselves) were considered relevant to the quantitative part of the review. The mean year of report appearance was 1981.72 (SD = 5.95, range = 1962 to 1990). The average study sample size (i.e., the number of groups or individuals, depending on the each study's unit of analysis) was 72.91 (SD = 58.42). About 48% (n = 34) of the studies included in the review used the replenishable resource paradigm, 36.6% (n = 26) used the NPD (or closely related) paradigm(s), and 15.5% (n = 11) used other paradigms. Most of the studies were performed in North America (81.7%, n = 57) and the Netherlands (14.1%, n = 10) . Two were conducted in Australia and one in Poland (together accounting for 4.2% of the total).

Resource Characteristics Whole versus Subdivided Resources (Privatization)

Six studies (Acheson, 1975; Cass & Edney, 1978; Edney & Bell, 1983; Martichuski & Bell, 1990; Messick & McClelland, 1983; Wilson, 1977) * that examined the relation between privatization of the commons (i.e., breaking it up into individually managed territories) and resource management efficiency were located. Four used

the replenishable resource paradigm and two were field studies. All studies reported that privatization improved resource management efficiency, although one field study (Acheson, 1975) had to be dropped because it lacked the necessary statistical information for the meta-analysis.

Probability analyses. The probability that the series of observed results could have occurred by chance was less than .001 ($Z = 4.33$). The Fail-safe N (i.e., the number of null-summing studies needed to raise the observed probability to over .05) was 29.7, only slightly below Rosenthal's (1979, cited in Cooper, 1984) suggested tolerance criterion for null results (i.e., 5 times the number of studies included in the analysis plus 10).

Effect size analyses. The mean effect size between privatization and resource management efficiency was .50 ($SD = .45$, $n = 5$). The effect sizes produced by the five privatization studies were significantly heterogeneous ($X^2[df = 4] = 26.19$, $p < .005$).

Using the hypothesis test (as opposed to the study) as the unit of analysis, a search for potential moderating factors was conducted. Study characteristics were broken down into dichotomous subgroups (e.g., characteristic present versus characteristic absent) and the correlation between study characteristic and effect size was calculated. If the correlation was significant,

the study characteristic was labeled a potentially important moderator-ratio-scaled subgroups (e.g., group size) were not dichotomized; a correlation was simply computed between characteristic and effect size. Finally, for study characteristics with greater than, two nominally-scaled subgroups (e.g., independent variable manipulation, dependent variable measure, etc.), a oneway analysis of variance was performed to determine if the mean effect sizes associated with each study characteristic subgrouping were significantly different. If the omnibus F was significant, Scheffe's range test was performed to determine which means significantly differed from each other. A summary of the mean effect sizes and standard deviations associated with each study characteristic subgrouping for the privatization studies is presented in Table 5.I.[2]

Table 5.1: Privatization Studies: Overall Effect Size and Average Effect Sizes for Subgroupings of Study Characteristics.

Privatization	Overall r = .50		Studies = 5
Characteristics	Average r	SD	N*
Paradigm**			15

Replenishable Resource	.52	.55	9
Field Study	.66	.00	6
Ecological Relevance**			15
Not Emphasized	.52	.55	9
Emphasized	.66	.00	6
Sample Composition**			15
Undergraduates	.52	.55	9
Non-Undergraduates	.66	.00	6
Group Size**			7
3-Person Group	.17	.11	4
4-Person Group	.86	.43	3
Dependent Measures**			15
Total Group Harvest	.39	.32	3
Rounds Pool Sustained	.41	.19	2
Points Replenished	.89		1
Points Remaining/Round	.93		1
# of Altruistic Responses	.00		1
Per Trial Harvest	.00		1
Field Measures	.66	.00	6

*N = number of hypothesis tests involving moderator and moderator subgroup (not the number of studies).

**Denotes significant (or marginally significant, $p <$ .10) moderator.

Five potential moderating factors (paradigm, ecological relevance, sample composition, group size, and dependent measure used) were identified. Paradigm, ecological relevance, and sample composition were all perfectly correlated with each other (i.e., they varied together from study to study), and therefore will be discussed together.

(1) Paradigm, ecological relevance, and sample composition. The average effect size for studies (a) using the replenishable resource paradigm, (b) not emphasizing the ecological relevance of the experimental task, and (c) using samples consisting of university undergraduates was .52 (SD = .55, n = 9). One study (Wilson, 1977) was conducted in the field using a small group of Maine lobstermen as subjects. It was assumed that the ecological relevance of the measured tasks must have been obvious to the subjects. Wilson's six dependent measures were all significant at the .005 level, yielding an average effect size of .66 (SD = .00). The correlation between paradigm/ecological relevance/sample composition (hypotheses tests associated with studies characterized by replenishable resource paradigm/ecological link not emphasized/undergraduate sample were coded as 0, and tests associated with the field study/ecological link obvious/non-undergraduate sample were coded as 1) and effect size was marginally

significant (r = .43, p =.06, n = 15). This indicates that relation between privatization and resource management efficiency tended to be weaker in laboratory studies than in the field study.

(2) Group size. The average effect size was .17 (SD = .11, n = 4) for studies using groups of three, and .86 (SD = .43, n = 3) for studies using groups of four. Group size and effect size were significantly correlated at .95 (p =.001, n = 7). The link between privatization and resource management efficiency was stronger for studies using larger group sizes than those using smaller group sizes.

(3) Dependent measures. Seven different dependent measures were used in the privatization studies. The average effect size associated with each measure are presented below: (a) "total harvest" (average r = .39, SD = .32, n = 3), (b) "points replenished to pool" (r = .89, n = 1), (c) "points remaining in the pool per trial" (r = .93, n = 1), (d) "rounds the resource pool was sustained" (average r = .43, SD = .19, n = 2), (e) "altruistic responses" (r = .00, n = 1), (f) "per trial harvest" (r = .00, n = 1), and (g) "field measures" (average r = .66, SD = .00, n = 6).

To determine whether the mean effect sizes associated with the dependent measure subgroups were significantly different, a one-way analysis of variance

with type of dependent measure as the independent variable and standardized effect size (Z_r) as the dependent variable was performed. The omnibus F was significant ($F[6,8] = 9.16$, $p < .003$). Post-hoc comparisons using Scheffe's range test (significance level = .10) revealed that the mean effect size associated with "points replenished to pool" was significantly greater than that associated with "altruistic responses". The mean effect size associated with "points remaining in the pool per trial" was significantly larger than all other subgroup means except except "field measures" and "points replenished to pool".

Breakdown of findings by significant moderators. Combined probabilities were calculated for each subgroup of paradigm, ecological relevance, group size, and sample composition (i.e., the study characteristics that were significantly correlated with effect size). The seven subgroupings of dependent measures were collapsed into three larger groups (subgroups producing effect sizes of 0.00, subgroups producing mean effect sizes greater than 0.00 but less than .50, and subgroups producing effect sizes over .50). Combined probabilities were computed for each of these larger groups.

(1) Paradigm, ecological relevance, and sample composition. The combined probability of the series of observed results from studies (a) using the replenishable

resource paradigm, (b) making no reference to the ecological relevance of the experimental task, and (c) using undergraduates as subjects, was less than .001 (Z = 3.6, n = 4). The probability associated with the results of the field study (in which the replenishable resource paradigm was not used, the ecological relevance of the task was obvious, and the sample did not consist of university undergraduates) was also significant (p =.005, Z = 2.57, n = 1). Thus the positive relation between privatization and resource management efficiency holds for both types of studies.

(2) Group size. Although studies using groups of 4 tended to produce larger effect sizes, the relation between privatization and resource management efficiency was significant for both studies using groups of 3 (p =.027, Z = 1.94, n = 2) and studies using groups of 4 (p = .001, Z = 3.20, n = 1).

(3) Dependent measures.[3] The probability associated with hypothesis tests using "per trial harvest" or "altruistic responses" as the dependent measure was exactly .5 (Z = 0, n = 2). For tests using "total harvest" or "rounds the pool was sustained" as the dependent measures the probability was less than .001 (Z = 4.6, n = 5). Finally, for tests using "points replenished", "points remaining in pool per trial", or

"field measures" the probability was less than .001 (Z = 7.7, n = 8).

Interactions involving the privatization variable. Cass and Edney (1978) report two significant interactions between privatization and feedback about the resource pool ($F[1,20] = 43.75$, $p < .001$, $r = .83$, DV = number of points left remaining the pool per round, and $F[1,20] = 6.89$, $p < .016$, $r = .51$, DV = total number of points replenished to pool). In the privatization condition the absence of resource pool feedback resulted in a tendency towards overcautious harvesting, whereas in the common pool condition it led to over-harvesting.

Resource Use

Twelve studies (Kramer & Brewer, 1984; Kramer et al., 1986; Messick et al., 1983; Rutte & Wilke, 1984; Samuelson, 1990; Samuelson & Messick, 1986a; Samuelson & Messick, 1986b; Samuelson, et al. 1986; Schroeder et al., 1983) examined how bogus feedback suggesting that the resource pool is being overused affects subsequent harvest decisions. Eight studies reported that subjects decreased their harvests in response to feedback indicating overuse. Two studies reported harvest rates increased, and two others reported null results with no direction given.

Probability analyses. The probability associated with the combined set of individual probabilities was

less than .001 (Z = 4.0). The Fail-safe N was 60.43, just below Rosenthal's suggested tolerance level for null effects.

Effect size analyses. The mean effect size across all studies included in the analysis was .14 (SD = .29, n = 12). A homogeneity analysis revealed that the effect sizes were significantly heterogeneous and three significant moderators (paradigm, group size, and dependent measure used) were identified. Paradigm and group size were perfectly correlated with each other and therefore will be discussed together. A summary of the mean effect sizes associated with all study characteristic subgroups for the resource use studies is presented in Table 5.2.

Table 5.2: Resource Use Studies: Overall Effect Size and Average Effect Sizes for Subgroupings of Study Characteristics.

Feedback to suggest overuse	Overall r = .14		Studies = 12
Characteristics	Average r	SD	N
Paradigm**			13
Replenishable Resource	.24	.21	11

Social Trap	-.31	.03	2
Group Size**			13
4-Person Group	-.31	.03	2
6-Person Group	.24	.21	11
Culture			13
North American	.10	.30	10
Dutch	.33	.00	3
Resource Use Manipulation			13
Over vs Optimal/Underuse	.15	.29	12
Extreme vs Moderate Overuse	.28		1
Dependent Measures**			13
Per Trial Harvest	.23	.22	10
Total Group Harvest	-.31	.03	2
Deviation from Optimum	.33		1

*N = number of hypothesis tests involving moderator and moderator subgroup (not the number of studies).

**Denotes significant (or marginally significant, $p < .10$) moderator.

(1) Paradigm and group size. The average effect size for studies using the replenishable resource paradigm and 6-person groups was .24 (SD = .21, n = 11). Studies using a social trap analogue (characterized by a finite, non-regenerating resource pool), and 4-person groups yielded an average effect size of -.31 (SD = .03,

n = 2). The correlation between paradigm/group size (replenishable resource/6-person group = 0, social trap/4-person group = 1) and effect size was -.75 (p =.001, n = 13). Thus, feedback indicating the resource pool was being over-used facilitated cooperation in studies using the replenishable resource paradigm and groups of 6, but decreased cooperation in studies using the social trap paradigm and groups of 4.

(2) Dependent measures. Three different dependent measures were used in the studies reviewed. Tests using "harvest per trial" as the dependent measure produced an average effect size of .23 (SD = .22, n = 10). Those using "total group harvest" as the dependent measure yielded an average effect size of -.31 (SD = .03, n = 2). One test using "deviation from the theoretically optimal harvest" produced an effect size of .33.

A one-way analysis of variance with the dependent measure used as the independent variable and standardized effect size (Z_r) as the dependent variable was significant ($F[2,10] = 6.53$, $p < .02$). Post-hoc comparisons using Scheffe's range test (p = .10) revealed that the mean effect size associated with "total group harvest" was significantly different from those associated with both "harvest per trial" and "deviation from the theoretically optimal harvest". The means

associated with the latter two groups were not significantly different at .10.

Breakdown of findings by significant moderators. Combined probabilities were calculated for each subgrouping of significant moderators (i.e., paradigm, group size, and dependent measure used).

(1) Paradigm, group size, and dependent measure. The combined probability associated with studies using (a) the replenishable resource paradigm, (b) 6-person groups, and (c) either "harvest per trial" or "deviation from the theoretically optimal harvest" was less than .001 (Z = 5.9, n = 10). For studies using (a) the social trap paradigm, (b) 4-person groups, and (c) "total harvest" as the dependent measure the probability was .001 (Z = -3.3, n = 2). Thus, the combined results of both groups of studies were significant. However, the results were in opposite directions.

Interactions involving resource use. Several interactions involving the resource use variable were identified. Six of these were two-way interactions between resource use and trial blocks. In all studies, harvests tended to increase over trials when feedback indicated the resource pool was being optimally or underused. When feedback indicated that the resource pool was being overused, harvests either remained relatively stable or declined over trials.

Three studies reported significant two-way interactions between resource use and variance in others harvests. In the optimal use condition, subjects that were exposed to the high variance manipulation (subjects received feedback suggesting that some group members were making large harvests, whereas others were only taking a few points from the pool), tended to take more points for themselves than subjects exposed to low variance condition (subjects received feedback to indicate that all group members were harvesting approximately equal amounts from the resource pool). However, there were no differences between the two groups in the overuse condition.

A significant three-way interaction involving resource use, variance in others' harvests, and trial blocks was also located (Messick et al., 1983). In the underuse condition, high variance subjects (i.e., subjects receiving bogus feedback to suggest that some group members were aking large harvests and others were taking small harvests) tended to increase the size of their harvests over trials, whereas low variance subjects (i.e., subjects that received feedback that all other group members were harvesting at a moderate rate) tended to harvest at fairly constant lower rate. No clear harvest patterns were evident for subjects in the optimal

and overuse conditions ($F[8,296] = 2.03$, $p < .04$, $r = .19$).

Related studies. Two NPD-type studies, in which subjects were provided with false feedback about the choices of other group members, were found. Liebrand et al. (1986) reported that subjects who were given feedback indicating that the majority of the other group members were defecting cooperated less than subjects who were told that the majority of others were cooperating ($F[l,90] = 9.04$, $p < .003$, $r = .31$). This effect was mediated by the social value orientation of the subjects (i.e., there was a significant interaction between feedback and value orientation). Subjects initially classified as having a cooperative orientation were unaffected by the bogus feedback manipulation. However, subjects that were initially classified as non-cooperative, tended (a) to defect when the feedback indicated others were defecting and (b) cooperate when they received feedback that others were cooperating ($F[l,90] = 6.13$, $p < .02$, $r = .25$). A second study by Alcock and Manseli (1977) found no differences in cooperation between subjects who were given feedback that suggested others were defecting and subjects given feedback that indicated others were cooperating.

Other Resource Characteristics Influencing Cooperation/ Resource Management Efficiency

Pool size. Brechner (1977) compared the resource management efficiency of groups harvesting from large and small resource pools. It was hypothesized that the aversive consequences associated with over-harvesting would be more salient in the small pool condition and consequently harvesting efficiency should improve. Counter to this prediction, subjects in the large pool condition managed their resource pools more effectively ($F[1,20] = 4.55$, $p < .05$, $r = .46$).

Resource scarcity and surplus. In an experiment by Rutte, Wilke, and Messick (1987b), subjects were lead to believe that a present resource shortage or surplus was caused either by environmental or human factors. Subjects harvested significantly more in the surplus condition than in the scarcity condition ($F[1,68] = 255.88$, $p < .001$, $r = .89$). The "perceived cause" manipulation was not significant. However, there was a significant interaction between resource state (scarcity versus surplus) and perceived cause (environment versus human factors). The difference between the mean harvest in the shortage and surplus conditions was greater when environmental factors were perceived to be responsible for the state of the resource pool than when human factors were perceived to be responsible.

Participant Characteristics

Gender

Thirteen studies (Caldwell, 1976; Fleishman, 1988; Fox & Guyer, 1978; Gifford, 1982; Goehring & Kahan, 1976; Hamburger et al., 1975; Kramer & Brewer, 1984; Liebrand, 1984; Liebrand & Van Run, 1985; Meaux, 1973; Moore et al., 1987; Powers & Boyle, 1983; Rutte et al., 1987) that examined the relation between gender and cooperation/resource management efficiency were identified. Five studies reported that females were more cooperative than males, one reported males being more cooperative, and seven reported null results with no direction given.

Probability and effect size analyses. The combined probability of the 13 gender studies was only marginally significant (p =.079, Z = 1.41). The cumulative effect size across all studies was extremely small (r = .05, SD = .097, n = 13). A homogeneity analysis revealed that the effect sizes were not significantly heterogeneous. This suggests the observed variance in effect sizes was most likely due to chance. Following the conventions outlined earlier, no moderator search was conducted.

Interactions that involve gender are discussed in the communication and decision framing sections of this chapter.

Personality

Only two studies (Bixenstine & Douglas, 1967; Meux, 1973) were located that examined the relation between personality factors and cooperation/resource management efficiency.

Psychopathology. Bixenstine and Douglas (1967), in a study using the NPD paradigm, found that participants who scored highly on the MMPI (short-form) psychopathology subscale were only slightly less cooperative than non-psychopaths ($F[1,12] = 3.26$, $p < .10$, $r = .46$). Of greater interest, was a significant interaction between psychopathology and communication; non-psychopathic subjects benefited from the opportunity to communicate, whereas the psychopaths did not ($F[1,12] = 5.00$, $p < .05$, $r = .54$).

The 1/Nth personality. 1/Nth situations are those in which the behavior of any one person will have only a tiny effect on an overall outcome, yet the cumulative effect of individual actions may be staggering. Hardin's commons parable is an excellent example of a 1/Nth situation. If one herdsman adds a head of cattle to the commons, the impact is negligible. However, if all choose to increase the size of their herds, the commons may be destroyed. Meaux (1973) hypothesized that certain types of people (i.e., people scoring highly on the 1/Nth scale) are more likely to act cooperatively in 1/Nth

situations than others. Meaux's general hypothesis was supported; subjects with high 1/Nth scores made more cooperative responses than those with low scores ($F[1,48] = 8.12$, $p < .006$, $r = .40$). However, a significant interaction indicated that the relation held for female subjects only ($F[1,48] = 4.20$, $p < .05$, $r = .28$).

Previous Experience

Two studies (Allison & Messick, 1985; Gifford, 1982) examined whether previous experience with commons dilemmas improves resource management efficiency. Both studies reported positive findings.

Probability and effect size analyses. The joint probability that the observed results occurred by chance was less than .004 ($Z = 2.81$). The number of null-summing results needed to bring this probability to .05 was only 3.85. The size of this number is probably attributable to the small number of studies included in the analysis. The mean effect size for the two studies was .30 ($SD = .16$). The homogeneity analysis recommended by Cooper (1984) and Rosenthal (1984) and used throughout this chapter requires three or more studies and consequently could not be used. However, given that the effect sizes associated with both studies were positive and of moderate size, there was no reason to suspect that methodological factors moderated the relation between previous experience and resource management efficiency.

Type of experience. In addition to uncovering evidence suggesting that previous experience increases cooperation, Allison and Messick (1985) found that prior individual experience is more effective than prior group experience. This effect was especially pronounced for subjects who participated in large groups ($F[2,48] = 5.61$, $p < .01$, $r = .35$, DV = rounds pool sustained; $F[2,222] = 10.75$, $p < .001$, $r = .26$, DV = individual harvest per trial).

Social (Individual versus Group) Identity

Seven studies (Baird, 1982; Brewer & Kramer, 1986; Grzelak & Tyszka, 1974; Kramer & Brewer, 1984; Tindall & O'Connor, 1987) focused on the relation between social identity and cooperation/resource management efficiency. One study (Grzelak & Tyszka, 1974) was dropped from the analysis because the statistical information necessary for meta-analysis was not provided. Of those studies analyzed, three reported a positive relation between group identity and cooperation/resource management efficiency, and three reported null results with no direction given.

Probability analyses. The combined probability for the social identity studies was less than .004 ($Z = 2.63$, $n = 6$). The number of null-summing studies needed to raise this probability above .05 was 9.35, well below the tolerance criterion suggested by Rosenthal.

Effect size analyses. The average effect size across studies was .18 (SD = .20, n = 6), indicating that individuals (or groups) with a strong group identity tended to cooperate or manage resources more efficiently than those with a strong individual identity. A homogeneity analysis revealed that the effect sizes were significantly heterogeneous ($X^2[5] = 14.97$, $p < .025$).

Two methodological features (regeneration rate and type of social identity manipulation) were identified as a potential moderators of the relation between social identity and cooperation/resource management efficiency. A summary of the moderator search is Table 5.3.

Table 5.3: Social Identity Studies: Overall Effect Size and Average Effect Sizes for Subgroupings of Study Characteristics.

Group Identity	Overall r = .18		Studies = 6
Characteristics	Average r	SD	N*
Ecological Relevance			9
Not Emphasized	.29	.33	4
Emphasized	.16	.22	5

			132
Feedback About Others			11
No	.42		1
Yes	.15	.25	10
Regeneration Rate**			11
Constant	.32	.29	5
Variable	.06	.14	6
Group Size			9
3-Person Group	.32	.29	5
6-Person Group	.08	.17	4
Social Identity Manipulation**			11
Common Fate	.00	.00	3
Black Technique	.00	.00	2
Natural Category Distinct	.11	.19	3
Prior Sharing	.53	.01	2
Post-Exper Questionnaire	.42		1
Dependent Measures			11
Total Group Harvest	.29	.39	2
Per Trial Harvest	.06	.14	6
Points Replenished	.29	.40	2
OIDXS***	.42		1

*N = number of hypothesis tests involving moderator and moderator subgroup (not the number of studies).

**Denotes significant (or marginally significant, $p <$ .10) moderator.

***Observed-ideal difference index score (the average difference per trial between an individual's observed strategy and an ideal resource management strategy).

(1) Regeneration rate. Studies that employed a constant regeneration rate produced an average effect size of .32 (SD = .29, n = 5), whereas studies using a variable rate produced an average effect size of only .06 (SD = .14, n = 6). The correlation between regeneration rate (0 = constant, 1 = variable) was -.54 (p = .04, n = 11), indicating that the relation between social identity and effect and cooperation/resource management efficiency tended to be stronger in studies using constant regeneration rates.

(2) Social identity manipulations. Five different procedures were used to manipulate social identity in the studies reviewed. Those studies using the "common fate manipulation" (in the high group identity condition, a group pay-rate was determined by a lottery and participants were referred to as group members, whereas in individual identity condition, pay-rates were determined for each subject separately and participants were referred to as individuals) or the "Black technique" (bogus test results suggested that the group members were either very similar or very different) all yielded null

results (n = 3). Studies that attempted to create a superordinate or differentiated group identity on the basis of naturally occurring similarities and differences among group members produced an average effect size of .11 (SD = .29, n = 3). A mean effect size of .53 (SD = .01, n = 2) was produced by a study that created a sense of group identity by encouraging sharing among group members during a earlier task. In another study, subjects were simply asked (in a post-experimental questionnaire) if they tended to think of themselves as a group member or as an individual during the harvesting task (r = .42, n = 1).

To determine whether the mean effect sizes associated with each social identity manipulation were significantly different, a one-way analysis of variance with social identity manipulation as the independent variable and standardized effect size as the dependent variable was performed ($F[4,6] = 11.45$, $p < .006$). The results from Scheffe's range test indicated that mean effect size (measuring the relation between group identity and cooperation) associated with the "prior sharing" manipulation was significantly greater (at the .10 level) than those produced by all manipulations except the "post-experimental questionnaire". No other means differed significantly.

Breakdown of findings by significant moderators.

(1) Regeneration rate. The combined probability associated with the social identity studies that used a constant regeneration rate was less than .002 (Z = 3.00, n = 2). The combined probability associated with studies that used a variable regeneration rate was less than .14 (Z = 1.1, n = 4). Thus, the relation between social identity and cooperation/resource management efficiency held only for those studies employing a constant regeneration rate.

(2) Social identity manipulation. Studies in this section were divided into two groups based on the type of social identity manipulation used. The probability associated with studies using "prior sharing" or the "post-experimental questionnaire" was less than .001 (Z = 3.71, n = 2). For studies using the "common fate manipulation", the "Black technique", and "natural category distinctions" the combined probability was less than .10 (Z = 1.27, n = 5). Thus, the relation between group identity and cooperation/resource management efficiency appears to hold for only the studies using the "prior sharing" manipulation or the "post-experimental questionnaire" measure of social identity.

A significant three-way interaction involving social identity, decision framing, and group size is discussed in the section on group size.

Social Values

Six studies (Alcock & Mansell, 1977; Kramer et al., 1986; Liebrand et al., 1986; Samuelson, 1990) examined the relation between social values and cooperation/resource management efficiency. The studies compared the behavior of subjects who had been classified, prior to the experimental task, as possessing cooperative or non-cooperative orientations. Not surprisingly, four of the six studies report positive relations between cooperative dispositions and cooperation/resource management efficiency. One study reported null results with no direction given and one study (Alcock & Mansell, 1977, experiment #3) was dropped because it lacked the statistical information necessary for meta-analysis.

Probability analyses. The combined probability that the run of observed results could have occurred by chance was less than .001 (Z = 5.1). The Fail-safe N was 43.14, representing relatively strong evidence that a real relation between cooperative social values and cooperation/resource management efficiency exists.

Effect size analyses. The average effect size across all the social value studies was .43 (SD = .31, n = 5). A homogeneity analysis revealed that the effect sizes were significantly heterogeneous (X^2[df = 4] =

Three study characteristics (paradigm, group size, and dependent measure used) were significantly (or marginally significantly) correlated with effect size. A summary of the mean effect sizes and standard deviations associated each study characteristic subgrouping for the social value studies is presented in Table 5.4. Paradigm and dependent measure used were perfectly correlated with each other. They will, therefore, be discussed together.

Table 5.4: Social Value Studies: Overall Effect Size and Average Effect Sizes for Subgroupings of Study Characteristics.

Cooperative Orientation Overall r = .43 Studies = 6

Characteristics	Average r	SD	N*
Paradigm**			
Replenishable Resource	.19	.27	6
NPD	.52	.22	2
Ecological Relevance			4
Not Emphasized	.37	.07	6
Emphasized	.47	.41	3
Group Size**			3
6-Person Group	.19	.27	6
8-Person Group	.37	.10	2

10-Person Group	.64	.08	2
Culture			6
North American	.44	.35	4
Dutch	.37	.10	2
Social Value Classification			6
Decomposed Game Score	.37	.07	3
Ring/Kuhlman Marshello Measure of Social Values	.00		1
Self-Predicted Cooperation	.64	.08	2
Dependent Measures**			6
Per Trial Harvest	.19	.27	2
% of Cooperative Choices	.52	.22	4

*N = number of hypothesis tests involving moderator and moderator subgroup (not the number of studies).

**Denotes significant (or marginally significant, $p <$ .10) moderator.

(1) Paradigm and dependent measure. The mean effect size for studies that used the replenishable resource paradigm and "per trial harvest" as the dependent measure was .19 (SD = .27, n = 2). Studies that used games resembling NPD paradigm and "percentage of cooperative choices" as the dependent variable yielded a mean effect size .52 (SD = .22, n = 4). The correlation between paradigm/dependent measure

(replenishable resource/"per trial harvest" = 0, and NPD/"percentage of cooperative choices") and effect size was .69 (p =.07, n = 6), indicating that studies using the NPD paradigm and "percentage of cooperative choices" as the dependent measure tended to produce larger effect sizes.

(2) Group size. Three different group sizes were used in the studies reviewed. Studies using 6-person groups produced an average effect size of .19 (SD = .27, n = 2). Studies using 8-person groups had an average effect size of .37 (SD = .10, n = 2), and those using 10-person groups yielded an average effect size of .64 (SD = .08). The correlation between group size and effect size was .85 (p =.02, n = 6). The relation between cooperative social values and cooperation/resource management efficiency appears to strengthen as group size increases.

Breakdown of findings by significant moderators. Combined probabilities were calculated for each subgrouping of paradigm, group size, and dependent measure.

(1) Paradigm and dependent measure. The combined probability for studies that used the replenishable resource paradigm and "per trial harvest" as the dependent measure was less than .05 (Z = 1.70, n = 2). For studies that used games similar to the NPD paradigm

it was less than .001 (Z = 5.2, n = 3). Thus, the relation between cooperative social values and cooperation/resource management efficiency was significant for both groups of studies.

(2) Group size. Although studies with larger group sizes tended to produce stronger effects than those with smaller group sizes, the probabilities associated with studies with 6, 8, and 10-person groups were all significant (6-person groups, p =.05, Z = 1.70, n = 2; 8-person groups, p =.003, Z = 2.75, n = 1; 10-person groups, p =.001, Z = 4.2, n = 2).

Interactions involving social values. Kramer et al. (1986) reported a significant three-way interaction between social value (cooperative versus noncooperative), resource use (bogus feedback indicating optimal use versus overuse) and trial blocks ($F[5,245]$ = 3.57, p < .004). In the optimal use condition, noncooperators initially took more points than cooperators. However, from the third trial block onward, the harvests of the two types of subjects were very similar. In the overuse condition, cooperators displayed increasing restraint in response to the rapidly decreasing resource pool, whereas noncooperators failed to adjust their harvests.

Related studies. Several studies were conceptually related to those described above, yet deemed not similar enough to be included in the meta-analysis. Harper

(1977) reports that fostering a cooperative behaviorial orientation (as opposed to a competitive orientation) among group members prior to a resource management task improves resource management efficiency (the average effect size produced over three hypotheses tests was .54). Liebrand (1984) and Liebrand and Van Run (1985) classified subjects as altruistic, cooperative, individualistic, or competitive prior to engaging in a resource management task using the Geometric and Kuhlman/Marshello social value classification procedures. The omnibus F's (no planned comparisons or trend analyses were performed) for both studies were significant (the average effect size over six hypotheses tests was .20). An examination of the cell means revealed that altruistic and cooperative subjects tended to use less of the scarce resource than subjects that were classified as individualistic or competitive. Liebrand and Van Run also reported a significant interaction between social values and trial blocks ($F[3,260] = 6.03$, $p < .001$, $r = .19$, Geometric measure, $F[1,235] = 3.86$, $p < .01$, $r = .14$, Kuhlman/Marshello measure). Differences in resource use by subjects in the four social value categories declined as the game progressed.

Trust

Four studies (Brann & Foddy, 1987; Messick et al., 1983; Moore et al., 1987; Tindall & O'Connor, 1987) that

investigated the relation between trust among group members and cooperation/resource management efficiency were located. Surprisingly, all four studies reported null results with no direction given.

Interactions involving trust. Three interactions that involved trust were identified. Messick et al. (1983) reported a three-way interaction between trust, resource use, and trial blocks ($F[8,236] = 2.23$, $p < .03$, $r = .22$). When bogus feedback indicated underuse or optimal use of the resource pool, both high- and low-trust subjects tended to increase their harvests over trials. When feedback suggested resource overuse, high-trust subjects displayed restraint, whereas the low-trust subjects tended to increase their harvests. Brann and Foddy (1987) found an interaction involving trust and resource pool feedback. When feedback indicated that the resource pool was being optimally used, high-trust subjects harvested more than low-trust subjects. However, when feedback indicated that the pool was being severely depleted, low-trust subjects took more ($F[3,72] = 3.32$, $p < .02$, $r = .22$). A third interaction involving trust, gender, and communication is described in the communication section of this chapter (cf. Moore et al., 1987).

Variance In Others' Harvests

Seven studies (Messick et al., 1983; Rutte & Wilke, 1984; Samuelson, 1990; Samuelson & Messick, 1986ab, Samuelson et al., 1984) investigated the relation between variance in others' harvests (i.e., participants were given bogus feedback indicating high versus low variance in the number of resource units harvested by the other group members) and cooperation/resource management efficiency. Only one reported that cooperation significantly decreased as variance increased. The six remaining studies reported null results with no direction given.

Probability analyses and effect size analyses. The probability that the series of observed results occurred by chance was not significant (p =.25, Z = .67). The average effect size across all studies was extremely low (r = .03, SD = .09, n = 7). The effect sizes were not significantly heterogeneous (X^2[df = 6] = 4.00, ns), and no search for moderators was conducted.

Interactions involving harvest variance. Three studies reported significant interactions between harvest variance and trial blocks. In studies by Samuelson and Messick (1986a) and Samuelson et al. (1984), subjects in the high variance condition increased harvests over trials, whereas subjects in the low variance condition maintained their harvests at a relatively constant rate

($F[4,648] = 2.89$, $p < .02$, $r = .16$; $F[4,320] = 6.05$, $p < .001$, $r = .35$). The results from a third study by Samuelson (1990) also suggested that subjects in the low variance condition maintained relatively constant harvest rates. Harvests in the high variance condition tended to be more variable, but there was no clear evidence to suggest that harvest rates increased over trials ($F[4,388] = 2.64$, $p < .03$, $r = .17$).

Other Participant Characteristics Influencing Cooperation/Resource Management Efficiency

Age. In a study that used the replenishable resource paradigm, Gifford (1982) compared the harvesting efficiency of children ranging in age from 3-16. In general, harvesting efficiency increased with age ($F[9,65] = 10.02$, $p < .001$, $r = .35$), although there was a small, non-significant, decrease for subjects aged 14-16. A significant interaction between age and gender was also reported; girls aged 3-8 tended to cooperate more than boys, boys aged 9-12 cooperated more than girls, 14 year old girls more than 14 year old boys, and 16 year old boys cooperated more than 16 year old girls ($F[9,65] = 2.68$, $p < .01$, $r = .25$).

Perceived attitude similarity. In a study by Smith, Bell, and Fusco (1988), subjects received false feedback to suggest that they either possessed similar or dissimilar attitudes to other members of their group. A

series of 15 post-hoc comparisons revealed that groups with members who perceived themselves as similar managed the resource pool more efficiently than groups with members perceiving themselves as dissimilar.

Culture. Only one study made explicit cultural comparisons with respect to harvest behavior. Liebrand and Van Run (1985) compared harvesting rates between Dutch and American subjects. Dutch subjects showed slightly more restraint than the Americans, but the difference was not significant ($F[1,266] = .004$, $p < .95$, $r = .004$). A significant interaction between culture and trial blocks was also reported; Dutch subjects initially harvested more the American subjects, by the final trial block the Americans were harvesting more ($F[2,265] = 8.65$, $p < .001$, $r = .20$).

Rules of the Game

Communication

Thirteen studies (Bixenstine & Douglas, 1967; Bixenstine et al., 1966; Brechner, 1973; Caldwell, 1976; Dawes et al., 1977; Edney & Harper, 1978; Harper, 1977; Grzelak & Tyszka, 1974; Jorgenson & Papciak, 1981; Liebrand, 1984; Rapoport et al., 1962; Bell et al., 1990) tested the hypothesis that allowing communication among group members facilitates cooperation/resource management efficiency. Two of these (Grzelak & Tyszka, 1974;

Rapoport et al., 1962) were not included in the analysis due to insufficient statistical information. Of the 11 studies entered into the analyses, 10 reported positive findings. The 11th study was coded as a null result.

Probability analyses. The cumulative probability for the 11 studies was less than .001 (Z = 8.50); the odds are less than 1 in a million that the series of results included in the analysis could have occurred by chance. The Fail-safe N was 282.46, indicating that 283 additional null result studies would be needed to raise the combined probability above $p < .05$. This is well above the "tolerance level" for null effects suggested by Rosenthal (1979; cited in Cooper, 1984).

Effect size analyses. The cumulative effect size for all the communication studies was .54 (SD =.32, n = 11), suggesting a relatively strong relation between communication and cooperation/resource management efficiency. A homogeneity analysis revealed that the effect sizes were significantly heterogeneous (X^2[df = 10] = 38.62, $p < .005$).

Only one study characteristic (group type) appeared to moderate the relation between communication and cooperation/resource management efficiency. A summary of the moderator search for the communication studies is presented in Table 5.5.

Table 5.5: Communication Studies: Overall Effect Size and Average Effect Sizes for Subgroupings of Study Characteristics.

Communication	Overall r = .54		Studies = 11
Characteristics	Average r	SD	N*
Paradigm			18
Replenishable Resource	.65	.19	11
NPD	.46	.43	6
Sequence Dilemma	.23		1
Anonymity			14
No	.56	.18	2
Yes	.58	.38	12
Ecological Relevance			16
Not Emphasized	.61	.33	15
Emphasized	.23		1
Feedback About Others			13
No	.40	.27	2
Yes	.57	.35	11
Iterations Known			11
No	.48	.32	8
Yes	.58	.46	3
Group Size			18
3-Person Groups	.65	.21	9

4-Person Groups	.63	.10	2
5-Person Groups	.00	.00	2
6-Person Groups	.56	.18	2
7-Person Groups	.22		1
8-Person Groups	.88	.42	2
Group type**			18
Same Sex Groups	.30	.36	4
Mixed Sex Groups	.64	.25	14
Culture			18
North American	.59	.31	17
Dutch	.23		1
Communication Manipulation			18
Communication (during task)	.55	.32	14
Communication (during break)	.56	.33	2
Relevant vs Irrelevant	.68	.42	2
Dependent Measures	.57	.32	18
Total Group Harvest	.54	.36	5
Per Trial Harvest	.23		1
Rounds Pool Sustained	.66	.17	3
Points Replenished	.60	.22	3
Range/Rounds	.76	.00	1
% of Cooperative Choices	.54	.41	5

*N = number of hypothesis tests involving moderator and moderator subgroup (not the number of studies).

**Denotes significant (or marginally significant, $p <$ .10) moderator.

(1) Group type. Studies using same-sex groups produced an average effect size of .30 (SD = .36, n = 4). For studies using mixed-sex groups the average effect size was .64 (SD = .25, n = 14). The correlation between group type (same-sex groups = 0, mixed-sex groups = 1) was .59 (p =.005, n = 18). Thus, the relation between communication and cooperation tended to be stronger in studies where mixed-sex groups, rather than same-sex groups, were used.

Breakdown of findings by significant moderators. The combined probability of studies that used same-sex groups was less than .02 (Z = 2.28, n = 3). For studies with mixed groups it was less than .001 (Z =8.57 , n = 8). Thus, although studies using mixed-sex groups tended to produce larger effect sizes than studies using same-sex groups, the relation between communication and cooperation/resource management was significant for both groups of studies

Interactions involving communication. Four significant interaction tests were located for studies that examined the communication variable. Jorgenson and Papciak (1981) reported a significant interaction between communication and feedback about the resource pool;

communication resulted in improved resource management efficiency (i.e., the overall harvest of the group increased) only when feedback was provided about the state of the resource pool (F[l,56] = 10.59, £ < .002 , r = .40)." In a study that used the NPD paradigm, Bixenstine et al. (1966) reported a significant interaction between communication and feedback about others' choices (F[l,12] = 13.50, p_ < .003, r - .73). Communication led to increased cooperation only when subjects were provided with feedback about whether or not others were cooperating or defecting- Bell et al. (1990) also found a significant interaction between communication and level of feedback. According to the authors,

> Level of feedback was inconsequential in the absence of communication, but with communication, feedback about the size of the remaining pool improved harvesting efficiency except when combined with (information about) others' harvests for individual rounds.

This not only provides further evidence of the link between communication and feedback, but also suggests that too much feedback may interfere with resource management efficiency. Finally, Moore **et al. (1987) found** a significant **three-way interaction involving**

communication, gender, and trust ($F[3,48] = 5.13$, $p < .003$, $r = .34$). High-trust males who were allowed to communicate with each other sustained the resource pool significantly longer than subjects in the other conditions.

Decision Framing

Three studies (Brewer & Kramer, 1986; Fleishman, 1988; Rutte et al., 1987a) examined the relation between decision framing (i.e., framing the dilemma in terms of a public goods problem or in terms of a common resource problem). One study reported that cooperation was higher in the commons-dilemma game than in the public goods game. The two remaining studies reported null results with no direction given.

Probability and effect size analyses. The combined probability of the three decision framing studies was not significant ($p = .18$, $Z = .90$). The mean effect size was .06 ($SD = .11$, $n = 5$). Together, these results suggest that people respond similarly (taking into account, of course, the limited scope of the dependent measures used in the studies reviewed) to dilemmas involving public goods and common resources. The homogeneity analysis was not significant ($X^2[df = 2] = 1.5$, ns), indicating that the effect sizes for all three studies were relatively similar. Following the conventions outlined earlier, no search for moderating factors was performed.

Interactions involving the decision framing variable. Four significant interactions involving decision framing were located. Using a bogus feedback manipulation suggesting the resource pool was being slowly depleted, Brewer and Kramer (1986) reported a significant interaction between frame and trial blocks (F[6,480j = 2.60, p < .02 , r = .23). Subjects in the public goods condition kept fewer points for themselves (became more cooperative) as the game progressed. However, on average, they were always less cooperative than those subjects in the commons condition, who maintained a relatively low harvest rate across all game trials.

Brewer and Kramer (1986) also provided their subjects with feedback suggesting that the resource pool was being rapidly depleted. In this context, a significant (but weak) three-way interaction involving decision framing, social identity, and group size was discovered (F[l,80] = 4.30, £ < .04 , r = .23). According to Kramer and Brewer (1986),

> Regardless of the size of the group they were in, individuals in the commons dilemma task for whom a collective identity had been made salient took less for themselves than did individuals with an individual-level identity,

and this was also the case in the small group - public goods condition. In the large group - public goods condition, however, this outcome was reversed, and it deviated from that obtained in any of the other conditions. In this case, individuals who adopted a collective identity kept more for themselves in comparison with those with an individual-level identity.

Fleishman (1988) also reported two significant interactions involving decision framing. Following the first round of play, bogus feedback was given suggesting the majority of participants were either cooperating or defecting. In the commons-dilemma condition cooperation increased when the bogus feedback indicated others were cooperating. However, an opposite trend was evident in the public goods condition; cooperation decreased in response to knowledge that others were cooperating ($F[l,28] = 4.32$, $p < .05$, $r = .37$).

A second three-way interaction between frame, gender, and trials was also reported. The author provided no explanation for this interaction and suggests that it may have occurred by chance. Forced Equal Outcomes

Three studies (Edney & Bell, 1983; 1984; **1987), all** of which used **the** replenishable resource paradigm, tested

the hypothesis that equal division of total harvests among group members would increase cooperation or resource management efficiency. The "forced equal outcomes" manipulation seems to resolve the conflict between individual and collective rationality inherent in many dilemma situations. Given that the group's total harvest is equally shared by all, the advantages associated with defecting are eliminated. All three studies reviewed here found a positive relation b*cween equal outcomes and cooperation/resource management efficiency.

Probability and effect size analyses. The cumulative probability of the three studies was less than .008 (Z = 2.42). However, the number of null-summing results needed to raise the overall probability to over .05 was only 3.50. The small Fail-safe N most likely resulted from the small number of studies included in the analysis.

The mean effect size was .23 (SD =.08, n = 3) . The effect sizes were not significantly heterogeneous (X^2 [df = 2] = .45, ns) and no moderator search was conducted.

Interactions involving forced equal outcomes. Only one significant interaction involving the equal outcomes variable was located. Edney and Bell (1987) manipulated equal outcomes (equal versus unequal) and freedom of consumption (free versus "unfree" - the subjects' choices

were either constrained or unconstrained by the experimenter) in a 2 X 2 factorial design. Only the combination of forced equal outcomes and freedom of consumption resulted in a significant increase in the groups' harvest productivity. None of the other three groups significantly differed from each another ($F[1,36] = 5.09$, $p < .03$, $r = .35$).

Feedback About Others' Choices or Harvests

Five studies (Bixenstine et al., 1966; Foddy, 1974; Grzelak & Tyszka, 1974; Schroeder et al., 1983) investigated the effect of providing feedback about others' choices or harvests on cooperation/resource management efficiency. The Grzelak and Tyszka (1974) study was dropped from the analysis due to insufficient statistical information. Of the four remaining studies, one reported positive (but nonsignificant) findings and three reported null results with no direction given.

Probability and effect size analyses. The combined probability of the four studies included in the analysis was only .27 ($Z = .60$) and the mean effect size was .12 ($SD = .23$, $n = 4$). The effect sizes across studies were not significantly heterogeneous ($X^2[df = 3] = 2.7$, ns). No search for moderators was conducted.

One interaction that involved feedback about others was found. It is described in the communication section.

Moral Suasion

Does advocating altruism or the Golden Rule improve resource management efficiency? Two studies (Edney & Bell, 1983; Martichuski & Bell, 1990) have addressed this question and both found that moral suasion works.

Probability and effect size analyses. The joint probability associated with the two studies was significant was less than .03 (Z = 1.94). The number of null-summing results necessary to bring this probability to over .05 was less than 1. The mean effect size for the two studies was .17 (SD = .02). Given that both studies produced positive results with similar effect sizes, there was no reason to suspect that methodological factors may have moderated the observed relation between moral suasion and resource management efficiency.

No significant interactions involving moral suasion were located.

Payoffs

Four studies (Bruins et al., 1989; Grzelak & Tyszka, 1974; Kelley & Grzelak, 1972; Schroeder & Johnson, 1982) examined the relation between payoffs and cooperation. The studies were conceptually distinct and therefore not suitable for meta-analysis. Each will be discussed separately.

Kelley and Grzelak (1972) found, not surprisingly, that as the cost of cooperation increases (relative to

what could be gained by defecting) cooperation decreases. Similarly, Grzelak and Tyszka (1974) report that as the payoffs for cooperative choice increase, so does cooperation. Note that when cooperation becomes the dominant strategy (i.e., when the payoffs for cooperation are greater than those for defection) the dilemma (at least from a theoretical gaming perspective) disappears.

Schroeder and Johnson (1983), in a social trap study characterized by a non-regenerating resource pool, applied various weights to the long-term consequences of cooperative behavior. In general, as the value of the long-term rewards increased relative to the value of short-term gains, cooperation increased ($F[3,70J = 2.80$, $p_ < .05$, $r = .19$) .

In an extremely interesting study using the NPD paradigm, Bruins, Liebrand and Wilke (1989) utilized different payoff matrices to manipulate the salience of fear and greed. As both fear (operationalized as the difference between the smaller payoff for being the sole cooperator and the larger payoff for defecting with the others) and greed (operationalized as the difference between larger payoff for being the sole defector and the smaller payoff for cooperating with the others) become more salient, cooperation decreased

(F[l,124] = 8.0, p < .005 , r = .25).

Public Choice

Three studies (Fox & Guyer, 1978; Jorgenson & Papciak, 1981; Schroeder et al., 1983) examined the relation between public decision-making and cooperation/resource management efficiency. One study reported that forcing subjects to make their decision in public increased cooperation, whereas another reported that public choice decreased cooperation. A third reported null results with no direction given.

Probability analyses. The combined probability for the three studies was not significant (£ =.44, Z^ = .14), suggesting that the series of observed results probably occurred by chance.

Effect size analyses. The mean effect size for three public choice studies was extremely small (r = .04, SD = .49). A homogeneity analysis revealed that the effect sizes were significantly heterogeneous (X^2fd_f = 2] = 12.20, p < .005). This alerted us to the possibility that methodological factors may moderate the relation between public choice and cooperation.

Due to the small number of hypotheses tests available, the standard moderator search procedure was abandoned in favour of a less rigorous approach. A breakdown analysis of study characteristics revealed that the public choice studies reviewed varied according to only two methodological features (paradigm and dependent

measure used). A summary of the breakdown analyses for the public choice studies is presented in Table 5.6.

Table 5.6: Public versus Private Choice: Overall Effect Size and Average Effect Sizes for Subgroupings of Study Characteristics.

Public Choice	Overall r = .04		Studies = 3
Characteristics	Average r	SD	N*
Paradigm			4
Replenishable Resource	.00	.00	2
NPD	.53		1
Social Trap	-.43		1
Dependent Measure			4
Total Harvest	-.23	.32	2
Rounds Pool Sustained	.00		1
% of Cooperative Choices	.53		1

*N = number of hypothesis tests involving moderator and moderator subgroup (not the of number studies).

(1) Paradigm. Three different paradigms were used in the public choice studies. One study used the replenishable resource paradigm and produced null results

(r =.00, SD = .00, n = 2). A second study that used the NPD paradigm reported that having subjects make their choices in the presence of other group members resulted in a significant increase in cooperation relative to conditions where subjects made their choices in private (r = .53, n = 1). A third study that used a social trap analog in which subjects harvested from a non-regenerating resource pool reported the exact opposite effect; those subjects that made their harvest decisions in private managed the resource pool more effectively than those who made their decision in public (r = -.43, n = 1).

(2) Dependent measures. Tests using "total harvest" as a dependent measure produced an average effect size of -.23 (SD = .32, n = 2), indicating that resource management efficiency decreased in the public choice condition. One hypothesis test used "number of rounds the resource pool was sustained" as the dependent measure and produced a null result with no direction given. A final study using "percentage of cooperative choices" as the dependent measure yielded an effect size of .53; cooperation increased in the public choice condition.

Breakdown of findings by potential moderators. Probabilities were calculated for each subgrouping of paradigm and dependent measure used.

(1) Paradigm. The probability of the study using the replenishable resource paradigm was exactly .5 (Z = 0). For the study that used the NPD paradigm it was less than .009 (Z = 2.39), and for the study using the social trap analog it was less than .02 (Z = -2.14). Thus, the relation between public choice and cooperation was nonsignificant for the study that used the replenishable resource paradigm, significant and positive for the study that used the NPD paradigm, and significant and negative for the social trap study.

(2) Dependent measures.[3] The probability associated with the hypothesis test that used "number of rounds the pool was sustained" as the dependent measure was .5 (Z = 0). For tests using "total harvest" as the dependent measure the probability was marginally significant (p =.07, Z = -1.51, n =2), and for the test using "percentage of cooperative choices" it was less than .009 (Z = 2.39).

There were no significant interactions involving the public choice variable.

Resource Pool Feedback

Four studies (Cass & Edney, 1978; Jorgenson & Papciak, 1981; Kline et al., 1984; Schroeder et al., 1983) examined the relation between feedback about the state of the resource pool and resource management efficiency. Three used the replenishable resource

paradigm and one used a social trap analog involving a finite, but non-regenerating resource pool. Two of four studies reported strong positive findings. The others reported null results with no direction given.

Probability analyses. The combined probability for all four studies was less than .002 (_Z = 2.89). The Fail-safe N was 8.30. Once again, this is well below Rosenthal's suggested "tolerance level" for null effects.

Effect size analyses. The mean effect size across all studies was .36 (2_=-44, n = 4). A homogeneity analysis revealed that the individual effect sizes were significantly heterogeneous (X^2[d_f = 3] = 17.94, p < .005} .

Due to the small number of hypothesis tests included in the resource pool feedback studies reviewed, once again the stringent requirements for identifying potential moderators was abandoned. A breakdown analysis of average effect size by potential moderator subgroupings revealed that the four studies included in the analysis were methodologically similar and varied according to only three major characteristics (paradigm, group size, and resource pool feedback manipulation: see Table 5.7 for a summary). Given that paradigm and resource pool feedback manipulation were perfectly correlated with each other, they will be discussed together.

Table 5.7: Resource Pool Feedback: Overall Effect Size and Average Effect Sizes for Subgroupings of Study Characteristics.

Resource Pool Feedback	Overall r = .36		Studies = 4
Characteristics	**Average r**	**SD**	**N***
Paradigm			6
Replenishable Resource	.53	.48	5
Social Trap	.00		1
Group Size			6
3-Person Group	.00		1
4-Person Group	.53	.48	5
Resource Feedback Manipulation			6
Feedback vs No Feedback	.53	.48	5
Constant vs Intermittent	.00		1

*N = number of hypothesis tests involving moderator and moderator subgroup (not the number of studies).

(1) Paradigm and resource pool feedback manipulation. The average effect size for studies that used the replenishable resource paradigm and compared the behavior of groups that were given resource pool feedback

with groups that were given no feedback was .53 (SI) = .48, n = 5). The effect size for the study that used the social trap paradigm and compared the effectiveness of constant feedback and intermittent feedback was .00. The correlation between paradigm/resource pool feedback manipulation and effect size was -.55 (p_ =.127, n = 6).

(2) Group size. Three studies used 4-person groups, producing an average effect size of .53 (SD = .48 n = 5). The fourth study, using 3-person groups, produced null findings (r = .00). The correlation between group size and effect size was .55 (g =.127, n = 5); studies with larger group sizes tended to produce larger effects.

Breakdown of findings by potential moderators. Probabilities were calculated for subgroupings of paradigm, group size, and resource pool feedback manipulation.

(1) Paradigm and resource pool feedback manipulation. The cumulative probability for studies that used the replenishable resource paradigm and compared feedback versus no feedback conditions was less than .001 (Z = 3.33, n = 3). The study that used the social trap paradigm and compared constant versus intermittent feedback conditions yielded null results (£> = .5, !5 = 0). Thus, the relation between pool feedback and resource management efficiency appears to hold only for the first group of studies.

(2) Group size. The probability associated with the studies using 4-person groups was also .001 (Z = 3.33, n = 3). The probability for the study that used 3-person groups was .5 (Z = 0). Only studies using 4-person groups reported a significant relation between resource pool feedback and resource management efficiency.

Interactions involving resource pool feedback. Only one significant interaction involving the resource pool feedback variable was identified, it is described in the communication section.

Group Size

Eleven studies (Allison & Messick, 1985; Bonacich et al., 1976; Brewer & Kramer, 1986; Hamburger et al., 1975; Komorita & Lapworth, 1982; Komorita et al., 1980; Liebrand, 1984; Marwell & Schmidt, 1972; Messick & McClelland, 1983; Powers & Boyle, 1983) investigated the relation between group size and cooperation or resource management efficiency. One study (Bonacich et al., 1976) was dropped from the analysis because of insufficient statistical information.

Probability analyses. The combined probability for the 10 group size studies less than .001 (Z = 5.40), indicating that the odds are less than 3 in 10,000,000 that the series of results included in the analysis could have occurred by chance. The Fail-safe N was 97.93, well above Rosenthal's recommended tolerance level.

Effect size analyses. The average effect size for the group size studies was -.31 (SD =.25, n = 10). A homogeneity analysis revealed that effect sizes across studies were significantly heterogeneous (X^2[df = 9] = 24.52, p < .005).

Three methodological features (ecological relevance, regeneration rate, and group type) proved to be significant (or marginally significant) moderators of the relation between group size and cooperation/resource management efficiency. A summary of the mean effect sizes and standard deviations associated with each study characteristic subgrouping for the group size studies is presented in Table 5.8.

Table 5.8: Group Size Studies: Overall Effect Size and Average Effect Sizes for Subgroupings of Study Characteristics.

Group Size	Overall r = -.31		Studies = 10
Characteristics	Average r	SD	N*
Paradigm			14
Replenishable Resource	-.23	.25	7
NPD	-.35	.15	4
Other	-.26	.36	3

Ecological Relevance**			14
Not Emphasized	-.38	.24	7
Emphasized	-.16	.19	7
Feedback About Others			14
No	-.09		1
Yes	-.29	.24	13
Regeneration Rate**			8
Constant	-.29	.22	6
Variable	.00	.00	2
Group type**			14
Same Sex	-.41	.19	5
Mixed	-.19	.23	9
Culture			14
North American	-.29	.24	13
Dutch	-.09		1
Dependent Measures**			14
Per Trial Harvest	-.07	.12	5
Rounds Pool Sustained	-.42	.24	2
Per Capita Pool Remaining	-.45		1
# Groups Reaching Coop Soln	.00		1
% Cooperative Choices	-.41	.19	5

*N = number of hypothesis tests involving moderator and moderator subgroup (not the number of studies).

**Denotes significant (or marginally significant) moderator.

(1) Ecological relevance. The average effect size for studies in which the ecological relevance of the laboratory task was emphasized by the experimenters was .16 (SD = .19, n = 7). For studies that did not emphasize this link, the average effect size was .38 (SD = .24, n = 7). The correlation between ecological relevance (0 = not emphasized, 1 = emphasized) was -.50 (p =.04, n = 14); the relation between group size and cooperation was significantly larger in studies that did not emphasize the ecological relevance of the laboratory task.

(2) Regeneration rate. The average effect size for studies using a constant regeneration rate was .29 (SD = .22, n = 6). For studies using a variable rate it was .00 (SD = .00, n = 2). The correlation between regeneration rate (0 = constant, 1 = variable) and effect size was -.62 (p =.05, n = 8). Larger effect sizes tended to be produced by studies employing a resource pool that regenerated itself at a constant rate.

(3) Group type. Studies using same-sex groups produced an average effect size of .41 (SD = .19, n = 5), whereas studies using mixed groups produced an average effect size of .19 (SD = .23, n = 9). The correlation between group type (0 = same sex, 1 = mixed) and effect size was -.50 (p =.04, n = 14). The relation between

group size and cooperation was stronger for studies with same-sex groups than studies with mixed groups.

(4) Dependent measures. Five different dependent measures were used in the group size studies. Studies that employed "per trial harvest" as the dependent variable produced an average effect size of .07 (SD = .12, n = 5). Studies that used the "number of rounds the resource pool was sustained" produced a mean effect size of .42 (SD = .24, n = 2). One study used "per capita pool size remaining following the task" as a measure of cooperation (r = .49, n = 1). A null result was reported by a study that utilized the "number of groups reaching a cooperative solution" as the dependent measure. Finally, studies that used "percentage of cooperative responses" as the dependent measure produced an average effect size of .41 (SD = .19, n = 5).

To determine whether the mean effect sizes associated with each subgrouping were significantly different, a one-way analysis of variance with type of dependent measure as the independent variable and standardized effect size (Z_r) as the dependent variable was performed. The omnibus F was significant ($F[4,9]$ = 4.27, $p < .03$). Post-hoc comparisons using Scheffe's range test revealed that only two means were significantly different at the .10 level (the mean effect size of studies using "percentage of cooperative

responses" as the dependent measure was significantly greater than the mean effect size of studies using "per trial harvest".

Breakdown of findings by significant moderators. Combined probabilities were calculated for each subgrouping of study characteristics that were significantly correlated with effect size (i.e., ecological relevance, regeneration rate, and group type). In the case of dependent measure used, separate probabilities were calculated for subgroupings with mean effect sizes of less than .10, and subgroupings with mean effect sizes of greater than .10.

(1) Ecological relevance. The combined probability for studies in which the ecological relevance of the experimental task was highlighted was less than .03 (Z = 1.91, n = 4). For studies not emphasizing ecological relevance, the combined probability was less than .001 (Z = 5.40, n = 7). Thus, the relation between group size and cooperation/resource management efficiency was significant for both types of studies.

(2) Regeneration rate. The probability associated with studies using a constant replenishment rate was less than .002 (Z = 3.13, n = 2). Two null results with no direction given were produced by the study using a variable replenishment rate (p =.5, Z = 0). Thus, in studies with a regenerating resource pool, the relation

between group size and cooperation/resource management efficiency held only when regeneration occurred at a constant rate.

(3) Group type. The combined probability of the group size studies that used same sex groups was less than .001 (Z = 4.88, n = 5). For studies using mixed groups, the combined probability was also significant (p =.013, Z = 2.24, n = 6). The relation between group size and cooperation/resource management efficiency appears to hold regardless of whether same sex or mixed groups are used.

Interactions involving group size. Four significant interactions involving the group size variable were located. All involved group size and trial blocks. In a study using the replenishable resource paradigm, Messick and McClelland (1983) divided harvest trials into four sequential blocks (quartiles) and compared the average number of points taken among individuals and groups of different sizes per quartile. A significant group size by quartiles interaction was found ($F[6,45] = 2.73$, $p <$ .024, r = .47); groups with 3 and 6 members tended to have high initial harvests that declined rapidly over time (down to the level of the one-person groups), whereas the harvests of individuals (i.e., one-person groups) tended to be relatively constant across trials. In a similar study, Allison and Messick (1985) also found

that groups were more likely to over-harvest during the early trials than individuals ($F[1,447] = 4.44$, $p < .004$, $r = .21$). Komorita, Sweeney, and Kravitz (1980), in a study using the NPD paradigm, also report a significant interaction between group size and trial blocks ($F[2,144] = 3.84$, $p < .024$, $r = .22$). However, this interaction was different from those described above; cooperation decreased over time for groups of 4, but remained stable (at a slightly lower rate) for groups of 8.

A fourth interaction involving group size, decision framing, and social identity is discussed in the section on decision framing.

Providing Dilemma-Related Information and Strategies

Four studies (Edney & Harper, 1978; Rapoport, 1988; Schroeder et al., 1983; Stern, 1976) examined the effects of providing harvesters with (1) information about the commons dilemma, or (2) strategies about how to best to solve the dilemma. Two studies used the replenishable resource paradigm, one used a car pooling simulation, and one used a social trap analog. All four studies reported that providing relevant information and strategies improved resource management efficiency.

Probability and effect size analyses. The probability that the series of observed results could have occurred by chance was less than .001 ($Z = 3.45$, $n = 4$). The number of null-summing studies needed to raise

this probability above .05 was 13.59. The mean effect size calculated across all studies was .33 (*SD* = .30, *n* = 4). The effect sizes were not significantly heterogeneous (X^2[*df* = 3] = 5.72, ns) and therefore no moderator search was conducted.

Interactions involving the information variable. One significant interaction involving information and trial blocks was identified. Schroeder et al. (1983) compared the harvesting behavior of groups who were given only basic instructions about how to play the social trap game and groups who were told an optimal strategy in addition to the basic instructions. They found that cooperation was relatively high for both groups during the first few trials. However, over time cooperation decreased in the group receiving basic instructions while remaining stable in the group that was informed of the optimal harvesting strategy ($F[5,280] = 4.71$, $p < .001$, $r = .41$).

Reward and Punishment (Incentives)

Eight studies (Bell et al., 1989; Caldwell, 1976; Foddy, 1974; Kline et al., 1984; Komorita & Barth, 1985; Martichuski & Bell, 1990; Powers & Boyle, 1983; Stern, 1976) examined the effect of rewards (for cooperative actions) and punishment (for non-cooperative actions) on cooperation/resource management efficiency. Only studies that compared incentive versus no incentive conditions

were included in this portion of the analysis. Four of the eight studies reported that the presence of incentives increased cooperation, and four reported null results with no direction given.

Probability analyses. The combined probability that the series of observed results occurred by chance was less than .0025. The number of null summing studies needed to raise this probability above .05 was 15.36.

Effect size analyses. The average effect size for the eight incentive studies was .16 (SD = .179). A homogeneity test revealed that the effect sizes were not significantly heterogeneous.

Although there is some evidence that incentives may be a moderately effective means of inducing cooperation in social dilemmas, questions remain about the relative utility of reward and punishment? Two studies were identified that have addressed this issue. In a study using the NPD paradigm, Komorita and Barth (1985,) report that rewards led to significantly more cooperation than punishment ($F[1,54] = 6.96$, $p < .01$, $r = .34$). However, in a recent study using the replenishable resource paradigm, Martichuski and Bell (1990) report that although the presence of incentives increased overall harvesting efficiency, the type of incentive (reward versus punishment) did not appear to matter.

In an attempt to resolve these discrepant findings, using the hypothesis test as the unit of analysis, a correlation between incentive type (reward = 0 versus punishment = 1) and effect size was computed. The relation did not approach significance (r = .01, p =.482, n = 13).

Interactions involving the reward and punishment variable. One significant interaction was identified. This involved incentive type (reward versus punishment) and incentive size (small, medium, and large) (Komorita & Barth, 1985). Incentive type had a negligible effect for small and medium sizes, but reward was much more effective in facilitating cooperation when incentive size was large ($F[2,42] = 7.51$, $p < .002$, $r = .42$).

Other Rules of the Game Influencing Cooperation/ Resource Management Efficiency

Access to the resource. Samuelson and Messick (1986) compared the harvest behavior of subjects with high (could harvest between 0 to 30 points per trial) and low access to the resource pool (could harvest between 0 to 10 points per trial). Subjects with high access took advantage of their privileged status and harvested significantly more than those with low access ($F[1,62] = 31.62$, $p < .001$, $r = .34$).

Perceived task difficulty. In a study by Samuelson (1990), subjects were instructed to collect as many

points as possible from a regenerating resource pool without extinguishing the pool. In addition to these basic instructions, half the subjects were led to believe the task was easy and most other groups had performed well. The other half were told that the task was difficult and that most other groups had performed poorly. The manipulation had virtually no effect on harvesting behavior ($F[1,88] = .15$, $p < .70$, $r = .04$).

Number of rounds played. In a study by Schroeder and Johnson (1982), subjects harvested points from a non-regenerating resource pool. The number of points that remained in the pool after a known number of rounds were given to each player. Thus, the optimal strategy was to leave as many points in the pool as possible. It was predicted that subjects in the "15 round" game would attach more value to the long-term consequences of their harvest decisions and therefore harvest less than those playing the "40-round" game. The result was not significant ($F[1,70] < 1$, ns, $r = .00$).

Time to reflect about one's choice. Dawes and Orbell (1982) speculated that providing subjects with more time to think about their choices might increase cooperation. Using a one-trial NPD game, subjects were either given 5 minutes or one day to consider their choices. No significant differences were found between

the number of cooperative choices made by the two types of groups.

Footnotes

[1]*h* number of articles included in the review reported results from more than one experiment on the same general topic (e.g., group size, communication, etc.). If separate samples were used for each experiment, the experiment (rather than the article) was treated as an independent data point. Thus, when we say-that we located X number of studies, we are referring to the number of independent experiments located, not the number of articles.

[2]Study characteristics that displayed no variance are not reported in the moderator search summary tables.

[3]Because a number of studies used multiple dependent measures, the hypothesis test, rather than the study, was used as the unit of analysis for this set of combined probabilities.

[4]This interaction was part of a weak three-way interaction that involved communication, resource pool feedback, and feedback about others actions. Because (1) the two-way interaction was much stronger than the three-way and (2) three-way interactions tend to be unstable, only the two-way is discussed here.

CHAPTER 6

Discussion

Important Factors Influencing Cooperation/Resource Management Efficiency

A summary of the average correlations between the reviewed factors and cooperation/resource management efficiency is presented in Table 6.1. Robustness coefficients (the Fisher Z-transformed Overall r divided by the Fisher Z-transformed SD) were computed for all correlations based on two or more studies. According to Rosenthal (1990),

> The utility of this coefficient is based on two ideas - first, that replication success, clarity, or robustness depends on homogeneity of the obtained effect size, and second, that it depends also on the unambiguity or clarity of the directionality of the result. Thus, a set of replication grows in robustness as the variance of the effect sizes decreases and as the distance of the mean effect size from zero increases.

The robustness coefficient, in itself, is not an intrinsically meaningful measure, that is, one cannot conclude that a finding is robust or not robust on the basis of the value of the coefficient. According to

Rosenthal (1990), the coefficient's main value is that it allows one to compare the relative robustness of different research areas, or in this case, a variety of experimental factors.

Despite its usefulness as a comparative heuristic, the robustness coefficient has a number of drawbacks as an index of replicability. The first drawback is that it fails to take into account the number of studies that contributed to the average effect size (R. Gifford, personal communication, August, 1990). We suggest that, in addition to effect size magnitude and variability, the number of times a finding has been successfully replicated represents an important aspect of robustness. For example, two factors that share identical effect sizes and standard deviations will produce identical robustness coefficients. However, if the effect size of the first factor was based on 10 successful replications and the second on only two, which effect size is more believable? We suspect that most people would choose the one based on 10 replications, since as the number of successful replications increase, the probability that the set of observed findings occurred by chance drops towards zero.

A second point that should be kept in mind when interpreting robustness coefficients is that the relative size of the coefficient is largely a function of effect

size variability. In several instances (e.g., moral suasion and forced equal outcomes), all of the studies that examined the relation between a specific factor and cooperation were conducted by the same research group and involved similar methods and samples. Not surprisingly, the variability among the effect sizes from these studies was quite small. It seems likely that the high robustness coefficients associated with these factors may reflect design homogeneity rather than true robustness.

In sum, the robustness coefficient represents a useful method for comparing the relative "believability" of the overall effect sizes associated with different experimental factors. However, in cases where overall effect sizes are based on small sample sizes or the findings of one research group, interpretation of coefficient size should be made with caution.

The factors in Table 6.1 are ranked according to the relative robustness of their effect sizes. Eight variables (moral suasion, forced equal outcomes, communication, group size, privatization, cooperative social values, previous experience, and providing dilemma related information and strategies) had robustness coefficients over 1.00. Each will be discussed separately.

Table 6.1: Overall Effect Sizes, Standard Deviations, and Robustness Coefficients for Factors Influencing Cooperation/Resource Management Efficiency in Commons Dilemmas.

Factor	Overall *r*	*SD*	*N*	Robustness
Moral Suasion	.17	.02	2	8.60
Forced Equal Outcomes	.23	.08	3	2.93
Previous Experience	.30	.16	2	1.93
Communication	.54	.32	11	1.82
Cooperative Social Values	.43	.31	5	1.48
Group Size	-.31	.25	10	1.26
Privatization	.50	.45	5	1.13
Providing Info/Strategy	.33	.30	4	1.11
Group Identity	.18	.20	6	0.90
Incentives	.16	.18	8	0.89
Resource Pool Feedback	.36	.44	4	0.80
Feedback/Others' Choices	.12	.23	4	0.52
Gender	.05	.10	13	0.50
Resource Overuse	.14	.29	12	0.47
Variance Others Harvests	.03	.09	7	0.33
Public Choice	.04	.49	3	0.08
Pool Size	.46		1	
Psychopathology	-.46		1	
1/Nth Personality	.40		1	

Age	.35		1
Access to Resource	.34		1
Perceived Task Difficulty	.04		1
Cause of Depletion	.00		1
Culture[b]	.00		1
Rounds Played	.00		1
Time to Reflect	.00		1
Trust	.00	.00	4

[a]N = number of studies used to calculate the mean effect size associated with each factor.

[a]Females tended to be more cooperative than males.

[b]Dutch and American university students were compared.

Moral Suasion. Our results suggest that moral suasion significantly increases resource management efficiency. According to Dawes (1980), moral suasion serves to increase the salience of personal utilities (altruistic norms, conscience, etc.) relative to payoff utilities, thereby enhancing the probability of a cooperative response. Although Dawes' assertion may, in fact, be correct, the method used to manipulate moral suasion in one of the studies (Edney & Bell, 1983 - the results of the second study were taken from a brief conference report that did not include a complete description of the manipulation) suggests an alternative

explanation having nothing to do with heightened morality. The experimenter's request for moral action were prefaced with "Now here is a way to make a lot of points." Subjects may not have interpreted the request as a moral appeal but rather as a strategy to maximize personal gain.

It is also worth noting that both moral suasion studies were conducted by the same research group at Colorado State University. Given that the second report (Martichuski & Bell, 1990) is incomplete, it is impossible to determine (in short order) if identical (or similar) methods were used in both studies. A brief review of past studies emerging from Colorado, however, reveals a high degree of methodological homogeneity suggesting that similar manipulations were probably used. If this is true, the robustness coefficient associated with the moral suasion factor is probably inflated.

Communication. Of all the variables reviewed, communication among group members had the largest average effect on cooperative choice and resource management efficiency (overall r = .54). The communication manipulation was probably effective for several reasons. Permitting communication enables group members to discuss strategies about the best possible ways to solve the dilemma, to negotiate binding contracts and commitments related to resource use, and to attempt to influence the

actions of others through the use of moral suasion and other coercive techniques. Furthermore, communication may help prevent panic in times of severe depletion. It has also be suggested that conununication may strengthen group identity and trust (Messick & Brewer, 1983) . Although this may be true, the present review, somewhat surprisingly, uncovered little evidence that either of these variables have a strong direct impact on cooperation.

Two significant interactions reported by Jorgeason and Papciak (1981) and Bixenstine et al. (1966) suggest that communication is especially important in situations where feedback is provided about the state of the resource pool and the choices of others. Content analyses of conversations held during communication studies reveal that dilemma-related strategies (e.g., discussions regarding harvest quotas and the formation of pacts and coalitions among group members) are often developed during the conversation period. If information about the resource pool is non-existent or incomplete, it may be difficult to develop effective harvesting strategies even if communication is permitted. Subjects may also be reluctant to enter into cooperative pacts if there exists no feedback mechanism to monitor compliance.

Some social dilemma researchers contend that the observed link between communication and cooperation may

have only limited implications in the real world. According to Messick and Brewer (1983),

> Most social dilemmas involve large collectivities that are extended in time and space, offering little or no opportunity for group members to communicate of negotiate a solution to the choice problem.

Is it appropriate to dismiss communication so readily? Certainly, recent innovations in communication technology (e.g., the latest developments in computers, satellites, and fibre optics) provide us with the ability to create extensive communication networks that could conceivably link huge segments of the world's population. Such networks may prove to be an effective tool in combatting large scale commons problems.

Cooperative Social Values. Subjects that were classified as having cooperative dispositions tended to display more restraint during the harvesting task than those who were classified as non-cooperative (overall r = .43). A significant interaction reported by Kramer et al. (1983) indicates that the relation between cooperative social values and restraint may be especially pronounced when there is feedback to suggest that the resource pool is severely depleted. Similar results have been documented involving the trust variable (Brann &

Foddy, 1987; Messick et al., 1983), when feedback suggests overuse, high-trusters display more restraint than low-trusters. Perhaps those with cooperative dispositions also tend to be high-trusters.

Group Size. The majority of the group size studies included in the review reported a negative relacion between group size and cooperation/resource management efficiency (overall r = -.31). There was also evidence that cooperation decreases as the number of groups in a commons increases (Komorita & Lapworth, 1982).

A number of explanations have been proposed to account for the group size effect. Messick and McClelland (1983) have suggested that the group size effect me .>e explained in terms of "social loafing" and "diffusic ci responsibility". For example, individual group members may believe that if they take more than their share others will compensate. Alternatively (or additionally), individuals may feel less personal responsibility for the welfare of the group as group size increases. A third well-known social psychological construct, "Deindividuation", may also play a role. According to Zimbardo (1970; cited in Deux & Wrightsman, 1988), conditions that increase anonymity (e.g., increased group size) may weaken normal social controls based on guilt, shame, and fear. As social control weakens cooperation may decline.

A fourth explanation, labelled the "big pool illusion", suggests that (at least part of) the group size effect may be an artifact of the group size manipulation typically used in replenishable resource studies. In most studies, the total number of points initially available to be harvested increases with group size (e.g., the initial pool size for a group of with five members would be larger than that for a group with three members). Messick and McClelland (1983) suggest that individual harvesters may 'ignore the number of other users and to focus only on the relation between one's harvest and the total resource available." If this interpretation is correct, one would expect to find the largest difference between small and large group harvests during the early trials of the task (i.e., when the difference between the total pool sizes would be the greatest). Two significant interactions between group size and trial blocks (Allison and Messick, 1985; Messick & McClelland, 1983) are consistent with this prediction.

Finally, Edney (1981) outlined a number of other functional benefits associated with reducing group size. These included: improved communication, reduced alienation of group members, and increased visibility of the actions of others. All of these factors may play an important role in the development of tacit and non-tacit cooperative arrangements among group members.

Interestingly, both of the group size studies that used variable (i.e., unpredictable) replenishment rates reported null results. It seems reasonable to suspect that resource pools characterized by unpredictable regeneration rates would be more difficult to manage than pools with predictable (i.e., constant) rates. Perhaps, the variable regeneration rate effect overwhelmed that of group size.

Forced equal outcomes. Dividing profits equally among all group members also appears to increase resource management efficiency in the commons (overall r = .23). As noted earlier (cf. discussion of forced equal outcomes in Chapter 5), forced equality eliminates the conflict between individual and group interests. Since all players are guaranteed identical payoffs.- the benefits associated with individualistic or competitive strategies are eliminated. Note, however, that in some situations (e.g., if the time discount rate is high), even in the presence of forced equality is employed, rates of defection may remain high.

Although this solution proved to be effective, we suspect that at least some individuals (especially those with a strong affinity for capitalism) may consider forced equality to be an unjustifiable violation of personal freedom. Others might argue that allocation systems based on the notion of equality lack the

competitive incentives necessary for hard work and progress. However, Edney and Bell (1984) note that regardless of one's ideological beliefs, allocation systems based on forced equality may be well suited for certain resources in certain situations (e.g., allocating water in times of shortage, dividing household electrical bills, etc.).

As a final note, it should be pointed out that (1) all of the forced equal outcomes studies were conducted by the same research group using similar methods, and (2) that only three studies were included in the analysis. Thus, the magnitude of the robustness coefficient should be interpreted with caution.

Privatization. All five of privatization studies included in this review reported that dividing up the commons into individually managed territories improved resource management efficiency (overall r = .50). The results of two field studies involving lobster fisheries (Acheson, 1975; Wilson, 1977) suggest that the benefits of privatization generalize to at least some segments of the real world. There was also some indication, from one of the laboratory studies (Cass & Edney, 1978), that privatization may facilitate resource conservation in situations in which only limited information about the state of the resource pool is available.

Why does privatization increase resource management efficiency? From an economic perspective, privatization serves to eliminate the conflict between individual and collective rationality. when a resource is privatized, the externalities related to resource overuse and depletion no longer are spread over all group members. Rather, most costs become concentrated on the sole owner. This may prove to be an effective deterrent against irresponsible resource use.

From a psychological perspective, other factors such as learning and personal security may be more important. For example, it may be easier for a sole manager to learn the relation between his or her choices and the state of the resource pool. According to Messick and McClelland (1983), "The relationship between one's choice and the group outcome becomes muddied as the number of others also influencing the outcome increases."

Privatization also increases individual security by reducing

> two sources of threat: (a) significant loss to the participant if trust collapses...and (b) the fear that another participant might exploit defensively because he or she fears significant loss (Edney, 1980).

Furthermore, breaking the commons down into smaller territories may help prevent the creation of shortages that threaten the well-being of the whole (Edney, 1981). Individual mismanagement may lead to the ruin of specific territories, but, other territories should not be threatened.

Messick and Brewer (1983) discussed the limitations of privatization and noted that some resources cannot be easily divided into territories. How does one privatize air or sunlight? Other resources may, in principle, be divided into territories, but the costs associated with husbandry and the prevention of territorial encroachment may exceed the benefits from privatization. Privatization solutions also raise the issue of initial allocation. Who will be given access and control over scarce resources? On what basis will these decision be made? As noted earlier (cf. Chapter 2, an economic perspective), questions such as these issues can become the focus of intense disputes and social unrest. Also note that privatization may not facilitate the conservation of slowly regenerating resources (e.g., whales and timber). If the time discount rate is high, the resource is likely to be extinguished regardless of whether it is privatized or held in common.

Providing dilemma-related information and strategies. Not surprisingly, all four studies that

examined the relation between providing dilemma-related information or strategies and resource management efficiency reported positive results (overall r = .33). According to Schroeder et al. (1983), when an optimal strategy is not provided harvesters will seek out information about appropriate behavior by observing the actions of the other group members. This can lead the group to adopt sub-optimal strategies that may spell disaster for the commons. When information or an optimal strategy is provided by a credible source, harvesters may be less inclined to base their own choices on the actions of others.

The results of the information/strategy studies indicate that education may prove to be a useful device for increasing cooperation in commons dilemmas. Note, however, that providing information and strategies to group members does not address the fundamental conflict between individual and collective rationality that is at the heart of most social dilemmas (the same is true for many of the other solutions discussed here). Even if all are taught the benefits of cooperation, defection remains the dominant strategy for each individual.

Previous experience. The notion that education may play an important role in solving commons dilemmas is further supported by findings of studies examining the relation between previous experience with commons

dilemmas and resource management efficiency. Both studies included in the analyses report that subjects who had previous experience the resource pool better than those with no previous experience (overall r ~ .30). Previous individual experience {as opposed to group experience) appears to be especially beneficial. Messick and McClelland's (1983) learning hypothesis (cf. discussion of group size) once again appears to be relevant (Allison & Messick, 1985) . Individual experience may be superior to group experience because it is easier for a sole harvester to learn the relation between his or her behavior and the resource pool. Once this relation is learned, subjects *can* apply their knowledge to the group situation.

Other potentially important factors. Five other factors (pool size, psychopathology, I/Nth personality, age, access to the resource) produced relatively large effect sizes (i.e., |.30j or above). However, because these effect sizes were based on single studies robustness coefficients could not be computed. Although it would be premature to conclude that these factors are important main effect variables (their effects have yet to be replicated), it seems reasonable to earmark them as a potentially important factors that deserve further study and theoretical elaboration.

Other interesting findings. Two of the three studies that examined the relation between public choice and cooperation/resource management efficiency produced significant results. However, the results were in the opposite direction (resulting in a deceptively small average effect size and robustness coefficient). Fox and Guyer (1978) found that cooperation increased when participants made their choices publicly, whereas Schroeder et al. (1983) reported that public choice hindered cooperation. A closer examination of the studies revealed that the NPD paradigm used by Fox and Guyer produced a substantially higher overall rate (for all conditions) of cooperative choice (approximately .41) than the social trap analog used by Schroeder et al. (approximately .25). When choices are made in public, participants become privy to the actions of other group members. If subjects realize that a relatively large proportion of the other members of their group are cooperating (as in the Fox and Guyer study), the pressure to conform might be quite high. However, if faced with mass defection (as in the Schroeder et al. study), there may be no impetus to cooperate.

It is also worth noting that none of the reviewed studies produced significant main effects for trust. The absence of an effect may be related to the methods used to measure trust. In three of the four trust studies,

trust was measured fay a pre-experimentai questionnaire. If trust develops situationally (as the harvesting task progresses), pre-experimental measures may not accurately reflect actual levels of trust during the task.

A recent study by Tindall and O'Connor (1987) has produced results that run counter to this argument. Participants were asked, after the harvest task had be completed, to rate how much they trusted the other group members. Consistent with previous findings, no relationship between trust and harvesting efficiency was found.

Although there is evidence to indicate that trust may not be directly related (i.e., in a main effect sense) to cooperation and resource management efficiency, the importance of trust should not be overlooked. As noted earlier, two significant interactions (Brann & Foddy, 1987; Messick et al., 1983) suggest that trust among group members may exert an important influence on harvest decisions when the resource pool is being depleted.

Theoretical Implications

What do the present results suggest with respect to the commons-dilemma theories outlined earlier?

Limited processing theory. Dawes (19 80) posited that the high defection rates observed in most social dilemma simulations may be related to the brain's limited

that too much feedback may interfere with resource management efficiency.

Social trap theory. Social trap theory attempts to explain social dilemmas in reinforcement terminology. Platt (1973) suggested that regulatory agencies be created to administer counter-reinforcers to make cooperative choices more attractive. The results from reward and punishment studies included in the review suggest that introducing counter-reinforcers increases cooperation and resource management efficiency. However, the effect (the overall r was only .16) was not as dramatic as most behaviorists would have probably predicted.

Equity and tragic choice theories. Equity theory predicts that individuals who invest larger amounts of time and effort into the maintenance of the commons should take more of the resource for themselves. Although none of the studies reviewed here tested this notion using a commonly held resource pool (i.e., a pool from which all group members had access), Messick et al. (1983) reported that group leaders (who were elected to harvest points for the whole group) allocated significantly more points to themselves than to the other group members. This allocation pattern is consistent with that predicted by equity theory; the leader invested more effort than the other members and consequently

received a larger allotment. Note, however, that the observed pattern of allocation is also consistent with the notion of self-interest; greed, rather than equity, may have guided the leaders' actions. Further research is needed to distinguish between these alternative explanations.

Not surprisingly (given the difficulties associated with testing macro-level theories in experimental simulations), none of the research reviewed here appears to be relevant to Calabresi and Bobbitt's (1978) tragic choice theory.

The three-factor model of harvest decisions. The three factor model asserts that individual harvests decisions are guided by three motives. Evidence in support of the importance of each motive will be discussed separately.

(1) The desire to use the resource responsibly but efficiently. This hypothesis suggests that harvesters are motivated to increase the size of their harvests when feedback indicates the resource pool is being under-used (i.e., use the resource efficiently) and decrease their harvests when feedback indicates the pool is being over-used (i.e., that is use the resource responsibly). Six studies reported significant two-way interactions between the resource use variable and trial blocks; all indicated that harvest sizes tended to increase over trials when

feedback suggested resource underuse, and that harvests decreased (or remained constant) in response to feedback suggesting overuse. One study produced results that are inconsistent with the notion that individuals will attempt to use the resource pool responsibly. Schroeder et al. (1983) found that when feedback indicated that the resource pool was being over-used, harvests increased rather than decreased.

(2) The desire to conform to implicit group norms. This hypothesis suggests that in the presence of a salient group norm (e.g., when all members of the group harvest roughly the same amount from the resource pool) harvesters are motivated to conform to that norm even when it is not efficient or adaptive to do so. In other words, if the resource pool was being under-used, subjects would be not expected to increase the size of their harvests (i.e., use the resource efficiently) if all other group members were harvesting conservatively. Similarly, if the pool was being overused subjects would not be expected to decrease their harvests if all other group members were taking large harvests. Significant interactions involving feedback about resource use and variance in others' harvests support the first prediction but not the second. When feedback suggested that the resource pool was being underused, subjects did not increase their harvests unless there was a social model

for doing so. Harvests tended to decline or remain stable in the overuse condition regardless of the presence or absence of salient group norms. Thus, the conformity motive only appears to operate when the resource pool is not threatened.

(3) Willingness to trust others. Research by Messick et al. (1983) suggests that the trust motive may be important only when the resource pool is being overused (i.e., high trusters took significantly less than low trusters in the overuse condition, whereas no significant differences between high and low trusters were found in the underuse condition). However, the results of a study by Brann and Foddy (1987) indicate that trust may also be important when the resource pool is being under-used; high trusters were found to harvest significantly more than low trusters in this situation. Brann and Foddy explain their results in terms of reciprocal trust.

> Low trusters may have taken less in the underuse condition because they believed that if the resource pool declined they would be unable to influence others to show restraint...High trusters, who expected reciprocated restraint if necessary, could afford to increase their own consumption,

assuming that they, and others, would act responsibly if the circumstances changed.

More research is clearly needed to understand the role of trust in social dilemmas.

Game theory. Game theory is based on the assumption that most individuals will act in a economically rational manner (i.e., it assumes that when a clearly dominant option presents itself, it will be chosen). The results from the payoff studies included in this review lend some support to this position- Choices were found to be strongly related to the relative payoffs for cooperation and defection (i.e., rates of defection tended to increase as the payoffs for defection relative to those for cooperation increased). Note, however, that although defection is the dominant option in most social dilemmas, under certain conditions a substantial number of participants do in fact cooperate (even in one-shot games). This suggests that although individual economic rationality may be an important principle guiding harvest decisions, the relation is likely mediated by a number of other contextual factors.

Economic model of resource use. Almost all the studies included in the review examined the commons dilemma from a psychological rather than an economic perspective. Consequently, the results of the review

cannot affirm (or disaffirm) the correctness of many of the hypothesized relations between effort, total revenue, costs, shifts in demand, etc. proposed by the standard economic model present in Chapter 2 of this thesis.

However, at least one aspect of the present review seems to lend support to the standard model; dividing the resource pool into individually managed territories significantly improved resource management efficiency. The results from three privatization studies were detailed enough to allow us to determine whether the harvesters optimally managed their privatized segments, as economic theory predicts. The results from two of the studies (Cass & Edney, 1978; Edney & Bell, 1983) indicated that resource management in the privatization condition was close to optimal. However, the third study (Messick & McClelland, 1983) found that although privatization improved resource management efficiency, over half of those participants in the privatization condition still failed to maintain the resource for the full 50 rounds of the game.

General comments. A number of general comments regarding the relation between commons-dilemma theory and research are warranted. First, most of the theories discussed in this thesis seem to be at least partially supported by the results of the present review, that is, none of the reviewed theories were seriously refuted.

The theories that failed to completely account for the observed results could easily be modified to do so. Second, there appears to have been no attempt made by researchers to design studies that directly test the validity of one theory against that of another. However, because most of the theories focus on different aspects of the dilemma the absence of direct empirical comparisons is understandable. Third, many of the factors that have been shown to influence cooperation and resource management efficiency do not appear to be dealt with by present theory. Clearly, a serious attempt at theoretical integration is needed. The adoption of a developmental methodology similar to that described in the Chapter 2 may represent a positive first step in this direction. Methodological Implications

A review of the eight moderator search summaries (see tables 5.1 through 5.8) revealed that only two of the coded study characteristics (regeneration rate and group size) were consistently related to effect size. In addition to these two factors, methodological implications related to paradigm and culture will also be discussed.

Regeneration rate. In both moderator breakdowns involving regeneration rate, studies using constant regeneration rates produced significantly higher effect

sizes than studies using variable rates. In "constant rate" studies, subjects *can* determine how many resource units can be safely harvested from the resource pool each round. In "variable rate" studies, subjects are not told the exact regeneration rate for each round (although in most cases they are given a general range of rates), making it difficult to determine a safe level of harvesting. If the harvesting task is substantially more difficult in studies using variable replenishment rates, significant relations found in studies using constant regeneration rates may not generalize to studies using variable rates. We are presently conducting a study to test this assertion.

Group size. In a number of the moderator breakdowns involving group size, the average effect size produced by studies using large group sizes was larger than the average effect size produced by studies using smaller group sizes. It was suggested this trend may reflect a general magnification principle that may apply to all commons-dilemmas studies (R. Gifford, personal communication, June, 1990).

To test this hypothesis, a Pearson correlation was computed between group size and effect size for all hypotheses tests included in the review. The relation was not significant and was in the opposite direction to that predicted ($r = -.07$, £ = .18, $n = 168$).

Paradigm. Most previous reviews of social dilemmas have tended to combine the results of studies using the replenishable resource and NPD paradigms. Although the two paradigms are conceptually related, little evidence has been presented to suggest "hat cross-paradigm generalizations are warranted. This review produced such evidence. Although paradigm was identified as a potentially important moderator in five of the moderator searches, only two of these involved differences among studies using the replenishable resource and NPD paradigms. Social value studies using the replenishable resource paradigm tended to produce smaller effect sizes than those using the NPD paradigm, although a breakdown analysis revealed the probabilities associated with both sets of studies were significant (i.e., the relation between social values and cooperation/resource management efficiency held for both types of studies). A public choice study using the NPD paradigm produced significant results, whereas one using the replenishable resource paradigm did not. Further research would be required to determine if paradigm was, in fact, responsible for these differences.

During the review process, a number of other studies were located (and ultimately included in the review) that dealt with the commons dilemma but did not use the **NPD** or replenishable resource paradigas. A subset of these

studies, all of which used Schroeder's social trap paradigm, tended to produce results counter to those generated by the more standard paradigms (e.g., see the results associated with resource use feedback and public *choice).* A tentative explanation for the discrepant findings with involving the public choice variable was outlined earlier. A slightly different explanation will be offered to account for the cross-paradigm discrepancies in the "resource use" studies.

All of the "resource use" studies that used the replenishable resource paradigm were characterized by a variable replenishment rate. In the social trap paradigm, a non-regenerating resource pool was used. Subjects in the replenishable resource studies may have attributed the resource pool's decline to the unpredictable replenishment rate rather than the greed of the other group members. Subjects may have believed that they could still trust their fellow group members and therefore may have been willing to reduce their harvests in response to resource overuse. In the social trap study, subjects could not attribute the pool's demise to natural factors (e.g., regeneration rate). Resource overuse may have reduced trust among group members which may have resulted in further increases in harvesting.

One study related to this hypothesis has been conducted. Rutte et al. (1987) found that perceived

cause of scarcity (i.e., environmental cause versus human cause) was not significantly related with harvest behavior. However, because this finding has yet to be replicated, it may be premature to dismiss the attribution hypothesis.

Culture. One of the goals of this study was to make cross-cultural comparisons between studies performed in North America, the Netherlands, Australia, and Japan[x]. Only one study (Liebrand & Van Run, 1985) explicitly compared harvesting behavior in two cultures; no differences between American and Dutch college students were found. Similarly, none of the moderator searches revealed culture to be a potentially important moderator of the relation between any of the reviewed factors and cooperation/resource management efficiency.

Although these results seem to suggest that culture may not be *an* important commons-dilemma factor, we are, at present, reluctant to draw such a conclusion. At least two alternative explanations for the absence of significant findings seem plausible. First, almost all of the studies included in this review were performed in industrialized, western-style democracies. The cultures of these countries may have been too similar to produce significant variations in resource management strategies. Studies comparing the resource management styles of more diverse cultures (e.g., communist versus capitalist,

first world versus third world, etc-) may produce more dramatic differences.

Second, only a small proportion of the studies reviewed were performed outside of North America. Most of the individual meta-analyses included only a few (usually zero or one) foreign studies and a relatively large number North American studies. Unequal cell n's tend to reduce the power of correlational analyses; as cell sizes become more unequal, cell means must be increasingly different from each other to produce a significant result. Because the ratio of North American to foreign studies was usually quite high, the chance of identifying culture as an important moderator was extremely remote, even if real cultural differences did, in fact, exist.

Limitations of the Present Review

The results from the present review are limited in a number of respects. The first limitation stems from the coding methods used during the data collection stage of the study. In an ideal situation, all studies would be coded independently by at least two researchers. Coding sheets could be compared for accuracy and coders could consult each other about ambiguous information in the primary reports. Only one coder was used in the present study. To improve coding accuracy (and to clarify

ambiguities that became evident), almost half of the articles were reviewed more than once.

The second limitation of the review is related to the size of the samples used for some of the analyses. Many of the average effect sizes reported are based on only one or a few studies and therefore may not accurately measure the true relation between variables (although for the average effect sizes based on samples of two or larger, the robustness coefficient represents a useful indicator of which correlations are most believable).

The small sample sizes associated with certain analyses not only limits confidence in the cumulative probability and effect size statistics, they also reduce the power of subsequent moderator searches. Coded study characteristics were identified as potential moderators if (1) they were significantly correlated with effect size, or (2) the average effect sizes associated with different study characteristic sub-groupings were found to be significantly different. Unfortunately, when sample sizes are small, large differences between means are needed to obtain a significant result. Using the hypothesis test as unit of analysis for the moderator searches counteracted this problem slightly (sample size was increased relative to analyses that were conducted

with the study as the unit of analysis). However, it is likely that some real moderators were overlooked.

Small sample sizes have been acknowledged as a problem with this study. Note, however, that the same criticism could be directed at all past reviews of social dilemma research. Furthermore, although power was low for most moderator searches in this review, some significant moderators were indeed identified. Thus, the outcome was still more productive than most qualitative reviews in which systematic moderator searches are rarely attempted.

A third limitation of the present review involves the strategy adopted for coding interactions. Ideally, all interaction tests (significant and non-significant) should have been coded. However, from a practical standpoint, this strategy would have been difficult to employ. The omnibus F's, degrees of freedom, and probabilities (i.e., information vital to a quantitative review) associated with nonsignificant interaction tests are rarely reported. In fact, in many cases, researchers fail to report whether or not an interaction test was even conducted (although one can safely assume that it was and probably would have be reported had it been significant). If an especially conscientious reviewer was determined to code all interaction tests, he or she would not only have to gather information regarding all

those that had been formally reported in the primary research articles, but also figure out all the other conceivable interactions that could have taken place in each study and code them as being non-significant (i.e., assign tnem an effect size of 0).

The alternative adopted for this review was to code only those interactions that were significant. The drawback of this approach is that for every significant interaction involving a given set of variables there may be another group of interaction tests involving the same set of variables that did not produce significant results. In other words, the interactions reported in these reviews may not represent stable effects and should be interpreted with caution. Note that this problem represents another example of the sampling bias (or file drawer) problem discussed in Chapter 3. Future Research

Over 20 years of commons-dilemma research have been conducted. Although our understanding of the major factors influencing cooperation and resource management efficiency has increased dramatically during this period, our knowledge is far from complete. What still needs to be done? A number of suggestions for further research will be offered.

(1) The absence of a comprehensive commons-dilemma theory. Although a variety of commons-dilemma theories

have been proposed, each tends to focus only on specific aspects of the problem. Thus, although certain parts of the dilemma appear to be quite well understood in isolation, a comprehensive theoretical picture of common property problems has yet to emerge. The developmental methodology proposed by Tolman and Lemery (1989) may represent a useful framework for beginning to organize present knowledge into a coherent whole.

[This problem with commons-dilemma theory seems to be, on a smaller scale, the same as the one facing much of psychology. Research and theory proliferate in an ever-expanding web of disciplines and sub-disciplines, yet rarely are attempts made to integrate new discoveries into the larger scheme of things (i.e., tie everything into a internally consistent meta-theoretical framework)].

(2) Cross-cultural research. To date, there has been little theoretical or empirical work examining the role of culture in the commons dilemma. Cross-cultural research involving segments of the world with dramatically different political and economic systems may prove to be especially informative. Furthermore, studying the strategies employed by other cultures may alert western researchers to new solutions that have been previously overlooked.

(3) Alternative modes of research. Most of the research included in this review was conducted in laboratory settings. It may prove useful for cominons-dilemma researchers to consider alternatives to experimental research. For example, field research could be conducted to determine whether the effects observed in the laboratory generalize to real word settings. The energy conservation studies performed by Aronson and associates represent excellent examples of how commons-dilemma principles can be studied in the field.

A second alternative to experimental approaches is archival research. Historical documents could be reviewed to examine the relation between specific contextual factors (culture, political systems, group sizes, communication, etc.) and the types of solutions (if any) that are adopted to deal with common property problems. As noted in Chapter 2, archival research has Deen successfully used by economists to study the evolution of private property rights.

(4) Ontogenetic studies. One study has compared harvesting efficiency between different age groups (Gifford, 1982). Only young children and adolescents were studied. Research comparing all age ranges (i.e., children, adolescents, and young and old adults) is needed. Further theoretical work integrating age, culture, and harvest decisions may also be beneficial.

(5) Individual difference and personality variables. There has been relatively little research that has examined the role of individual difference and personality factors in commons dilemmas. The effect sizes associated with the three individual difference and personality variables included in this review (social values, psychopathology, and I/Nth personality) were among the largest in the whole review (the overall r's associated with the three variable were all .40 or over). It would be interesting to determine if other individual difference and personality factors also exert a strong influence on resource management decision making.

(6) The social trap paradigm. Studies using the social trap paradigm have produced a number of results that are inconsistent with findings from studies using other paradigms. Tentative explanations for these discrepancies have been offered and require testing.

(7) Variable replenishment rates. A number of findings suggest that studies using variable (unpredictable) replenishment rates tend to produce smaller effects than those using constant (predictable) regeneration rates. It was suggested that variable regeneration rates may have a deleterious effect on harvesting efficiency and that this effect may be so strong that manipulations typically leading to improved

resource management efficiency may be rendered ineffective. This assertion requires testing.

Footnotes

[1]All the Japanese studies we located dealt with the public goods problem and therefore were dropped from the analyses.

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Appendix A

COMMONS DILEMMA CODE SHEET

A. REFERENCE

1. Author(s)_____
2. Title_____
3. Journal_____Year___Vol._____Pgs_____
4. Source_____

B. METHODS

a. paradigm __ d. ecol ref__ g. rgn rate___ j. incent ___
b. anonymity__ e. unit __ h. FBpool ___ k. grpsize___
c. commun __ f. iter kwn__ i. FBother ___ l. other ___

Instructions_____

2. Independent Variable_____
   a. # of manip ___
      #1_____
      #2_____
      #3_____
3. Dependent Variable_____
   a. # of measures ___
      #1_____
      #2_____
      #3_____
4. Generalizability
   a. sample characteristics
      #total___ #males___ #females___ Undergrads___
   b. location
      country_____ university_____

Comments_____

5. Threats to Validity
   a._____
   b._____

C. RESULTS

1. Main Effects

a. IV#____DV#____
Design_____#/fact_____
DVvar_____dfErr_____
TestVal_____dfEff_____
p-level_____Effsize____
Direction of results
_____

b. IV#____DV#____
Design_____#/fact_____
DVvar_____dfErr_____
Testval_____dfEff_____
p-level_____Effsize____
Direction of results
_____

c. IV#____DV#____
Design_____#/fact_____
DVvar_____dfErr_____
TestVal_____dfEff_____
p-level_____Effsize____
Direction of results
_____

d. IV#____DV#____
Design_____#/fact_____
DVvar_____dfErr_____
Testval_____dfEff_____
p-level_____Effsize____
Direction of results
_____

2. Interactions

a. Interaction

#1_____

Design_____ #/fact_____

DVvar_____ dfErr_____

TestVal_____ dfEff_____

p-level_____ Effsize_____

Explanation of Interaction _____

_____

b. Interaction

#2_____

Design_____ #/fact_____

DVvar_____ dfErr_____

TestVal_____ dfEff_____

p-level_____ Effsize_____

Explanation of Interaction_____

_____

c. Interaction

#3_____

Design_____ fact_____

DVvar_____ dfErr_____

TestVal_____ dfEff_____

p-level_____ Effsize_____

Explanation of Interaction _____

_____

D. OTHER VARIABLES

1._____

2._____

3._____

4._____

5._____

E. COMMENTS

_____

_____

_____

_____

_____

_____

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