ENFORCEMENT OF WATER POLLUTION CONTROL LAW

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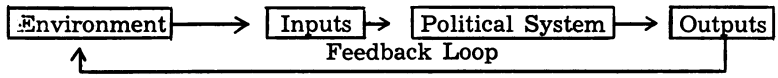
Theoretical Framework

Pollution control today is a favorite topic for campaign promises by American politicians. If the present public interest in the environment and problems of overpopulation continues, it may one day replace motherhood as the single safest subject for political rhetoric. Everyone, including polluters, is against pollution. But once that philosophical belief has been passionately embraced, the problem of achieving this highly desirable public policy goal remains. On that subject many politicians and all polluters are much less articulate. So many different opinions exist as to the best method for achieving air pollution control, water pollution abatement, and sanitary, efficient solid waste disposal, that one begins to understand why it is that little progress has been made despite the seemingly universal belief in a clean environment.

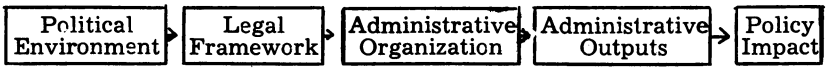
On the subject of water pollution alone, experts differ over such esoteric matters as the merits of applying cost-benefit analysis and the possible effectiveness of establishing effluent charges for all wastes deposited into water. While such arguments are far removed from a simple advocacy of clean water, they, too, are concerned with what should be rather than with

the method by which we may hope to achieve these ideals. This research was, therefore, undertaken not in order to argue the usefulness of any particular method of abating pollution, but rather to throw some light on the subject of how water pollution control law enforcement is being conducted in the United States today.

Most public policy problems can truly be said to have had no real beginning. It may be that a particular issue gains sudden prominence in public opinion after certain historical events. But in fact most public policy programs with which American politicians grapple today have been dealt with to some extent in the past. One of the strong points of David Easton's method of viewing the political system is the emphasis it places on the continuous nature of the process through which policy outputs at one point in time become the determinants of the inputs at a later date.[1]



The very nature of water pollution, which is both a relative and cumulative phenomenon, emphasizes the continuous, ongoing nature of the problem of attempting to control it. There has always been some degree of degradation of water, and it is, therefore, impossible to begin at the beginning. It is, however, possible to elaborate on the original model to produce a more detailed paradigm which may be used to explicate current activities in the field of water pollution control.



According to this model, it is hypothesized that the political environment will create a legal framework which an administrative agency will be able to utilize in order to produce enforcement outputs that will have the policy impact which the interests who originally argued for the legislation hoped to achieve. This is indeed a simple paradigm, but one which is implicit in much research and teaching done in the name of political science today, and therefore one worth investigating.

Laying aside for the moment questions concerning the first and last portions of the model, it is important to discover whether the central portion of the model functions as it has been depicted. Is the confidence placed in the administrative process by some students of public policy who end their investigation at the time when the legislature produces a statute

justified? Can one indeed predict administrative outputs based on our knowledge of the legal framework and the organization administering it? If so, is the bureaucracy a necessary intervening variable with an independent effect of its own, or may it safely be ignored provided one knows enough about the legal framework?

In order to begin to elicit answers to such questions, it was necessary to identify variables which indeed vary. Consequently, the state enforcement level, on which the burden of water pollution control enforcement has traditionally rested, was selected for research purposes. It is with the relative strictness of state water pollution control statutes, one easily identified and relevant benchmark in this public policy area, that this research began. Legitimated as they have been by the sanction given them by state legislators, such laws now represent the norms of the policy system which deals with water quality control. One would expect an easily demonstrable link between such readily identifiable norms and actual enforcement patterns. Yet, without empirical evidence it is far from clear that even such a basic assumption can be made.

Despite the lack of clarity in the way in which the central portion of the model — the little black box of the system — works, it is also important to ask questions concerning whether policy outputs have had any demonstrable impact on the environment and what the latter's effect on the process has been in the past and is likely to be in the future. Has our system of legal norms condemning pollution of waterways affected the actual state of the water? Can we identify political interests that have an effect on the legal norms and the administrative efforts that are made to control pollution? Does the physical environment itself affect activities in the public policy process? It was in order to develop answers to some of these questions that this research was undertaken.

Developing Indices for Variables

The first step in conducting this research was to operationalize the variables identified in the model. Multiple measures of each variable were found and combined by the use of factor analysis in order to reduce the danger of placing too much confidence on a single measure for which there was no external test of validity. Beginning with the legal framework, a method was developed for comparing state laws on the subject of water pollution control. Fortunately for the purposes of this study, at-

tempts have been made since the 1950s to standardize such state laws, and by 1969 all 50 states had recognized the relevance of a model law (Federal Water Pollution Control Administration, 1965) by adopting some of its provisions. It was, therefore, possible to compare each state law for similarities and differences with the model, as well as for strengths and weaknesses peculiar to each state, and to construct an index based on points assigned for these strengths and weaknesses.[2]

Regardless of the formal wording of laws, it is generally recognized by political scientists and public administrators alike that little can be accomplished unless the state legislature is also willing to devote some of the state's resources to the enforcement process. In order to compare the relative importance assigned by states to water pollution control work, an index of resources was also constructed, based on the monetary and human resources devoted to this program as a percentage of total available resources.[3]

In addition to resources necessary for enforcing the law, there are additional factors which may affect how strictly the law will be administered. One factor that many policy analysts point to as highly important to the administration of any law is the enforcement agency itself and its location in the broader framework of the governmental bureaucracy. At present, the 50 states represent considerable variety in respect to this factor. As on the national level, many at first located their water pollution control function inside the agency concerned with health, and by the end of 1969 many still kept the function there. Others, however, shifted this responsibility to their departments of natural resources and some created independent agencies (which occasionally combined the control of air and water pollution as well as solid waste disposal). This state of affairs allows some cross-state comparisons, although only at the nominal level of measurement.[4]

A second type of factor often discussed is whether administrators can best perform their task independently or when they are overseen by a supervisory commission. Many state laws specify that while a particular agency in the government will have responsibility for the day-to-day enforcement of the law, a policy-making board will make more general decisions concerning water pollution control. These boards differ, of course, as to the importance of the role they play — some are purely advisory — but it is possible in this type of study only to note the existence or lack of such a board in each state.

The makeup of such boards also varies from state to state. Some consist exclusively of government representatives. Others contain a mixture of government officials and representatives from the private sector. The latter can often be identified with the interest with which they are associated in the state, for in many cases the law specifically provides that the pollution control board will include representatives of major water users such as municipalities, industry, agriculture, and mining. Such representatives have been defined as "polluting interests" for the purposes of this study. In some cases the law also provides that groups which can be defined as "anti-polluting interests," such as conservation clubs, also be included. More commonly representatives are selected from the public at large, and while not all such individuals can be accurately termed "anti-polluters," they do all fall into the category of "non-polluters." In order to obtain a measure of the relative influence on such boards, the percentage of representatives of polluters was subtracted from the non-polluters.

Two very different types of variables may be used to measure the policy outputs of any state's water pollution control program. The first involves water quality standards set by the agency in charge of administering the law. The process by which such standards are created is a complex one, depending on the state in which it takes place, of course. Normally it includes a series of hearings in which opposing interest groups (fishermen and others using the body of water for recreation versus municipalities and industrialists using the same water for waste disposal) testify in favor of different criteria for each stretch of a river. Despite such public involvement, however, the first responsibility for conducting technical studies of the present quality of the water, the types of wastes being deposited in the water, as well as the kinds of uses which can be reasonably projected for the future belong to the personnel of the administrative agency. The latter are normally engineers and sanitarians, for biologists and chemists are present only in those state agencies which can afford a sophisticated administrative organization for this function. Despite the public clamor raised in the media while public hearings are in progress, the final decision on standards rests with these same technical personnel. Consequently, water quality standards set by individual states may be taken, in part, as a measure of the attitudes of the individuals whose function it is to administer the state water pollution control laws, and in part as a measure

of the political forces they feel impinge on them from the political environment.

Fortunately for the purposes of this study, the Federal Water Quality Act of 1965 authorized the establishment of federal water quality standards if the states had not by June, 1967, created their own standards. This fact, combined with the traditional states' desire to avoid federal regulation in areas they consider to be their own sphere of responsibility, served to produce standards for all states. Consequently, it was possible to construct an index which measures the relative strictness of state standards as they existed at the end of 1969.[5]

The second type of variable which can be used to measure the policy outputs of a state's water pollution control program concerns the actual enforcement procedures by which a state's water pollution control agency attempts to regulate water quality once standards are created. The three main processes by which state agencies attempt to regulate wastes being emptied into their waters are by: 1) issuing effluent permits to treatment plants, which include specific criteria for the operation of the plant in order to keep the permit in force; 2) requiring operating reports for the plants; and 3) inspecting them in order to determine whether or not the operating permits are being followed. An index was developed measuring the frequency and efficiency with which each of these procedures is carried out, as well as several auxiliary powers.[6]

Comparison of Variables

To sum up the research strategy thus far, the simple model originally postulated has been developed through identification of factors and measures for each variable, to produce the following research outline:

Variables:	**Legal Framework**	**Administrative Framework**	**Policy Outputs**
Factors:	Strictness of Law	I. Resources	I. Water Quality Standards
Measures:	A. Major powers	A. % of state budget	A. Complexity
	B. Exceptions	B. % of state employees	B. Best and worst limits
	C. Auxiliary powers	C. % of non-federal funds	C. Limits for same uses
	D. Penalties	D. % of requirement	D. F.W.Q.A. approval
Factors:		II. Types of agency	II. Enforcement efforts

Measures:	A. Department of government B. Policy board C. Representation of interests	A. % under permits B. % reporting C. % inspected D. Frequency of reports E. Frequency/ inspections F. Effluent checks G. Certification H. Ratio of orders to plants

An effort was then made to demonstrate linkages among these several factors through the calculation of Pearson's r product-moment correlation coefficients.[7] The following results were obtained:

FIGURE 1

	Strictness of Law	Resources Expended	Non-polluting Interests	Quality Standards	Enforcement Effort
Law	1.0000				
Resources	.2341	1.0000			
Interests	.0257	.3777	1.0000		
Standards	.1549	.0605	.2494	1.0000	
Enforcement	.2358	.3116	.1829	.0831	1.0000

None of these r values is especially impressive. Neverthless, there does seem to be some modest relationship between the enforcement effort made by the state agency and both the strictness of law and resources expended. Another cruder method for demonstrating these relationships is by grouping all factors into high, medium, and low categories and creating contingency tables, as below:

FIGURE 2

Strictness of Law

Enforcement Effort	Low	Medium	High	
Low	7 (43.8%)	5 (29.4%)	5 (29.4%)	17
Medium	5 (31.3%)	8 (47.1%)	3 (17.6%)	16
High	4 (25.0%)	4 (23.5%)	9 (52.9%)	17
	16	17	17	50

Resources Expended

Enforcement Effort				
Low	8 (50.0%)	6 (35.3%)	2 (11.8%)	16
Medium	5 (31.3%)	5 (29.4%)	7 (41.2%)	17
High	3 (18.7%)	6 (35.3%)	8 (47.1%)	17
	16	17	17	50

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In addition, the two factors not measurable by interval scales were compared with other factors by the same method of contingency tables. Whether or not the state has a policy and/or advisory board does not seem to affect the enforcement outputs, and this table has not been included. It would appear, however, that those states which have established a water pollution control agency in the natural resources division of their government have the best record of enforcement. Health departments and independent agencies alike have more "low" and "medium" outputs than they have "high" outputs, as seen below:

FIGURE 3

Enforcement Effort	Agency of Government: Health	Nat. Res.	Independent	
Low	11 (37.9%)	1 (11.1%)	5 (41.7%)	17
Medium	11 (37.9%)	1 (11.1%)	4 (33.3%)	16
High	7 (24.1%)	7 (77.8%)	3 (25.0%)	17
	29	9	12	50

In an attempt to determine what the cumulative effect of all four of the factors measurable in interval scales would have on enforcement effort, a stepwise multiple regression was performed which produced a multiple r of .36507, accounting for only about 13% of the variance among states in enforcement effort. We must, therefore, conclude that while states with relatively strict laws, large water-pollution control budgets, and a preponderance of non-polluters on governing boards are somewhat more likely to make a relatively strong enforcement effort, it is also possible for some states with weak laws, few resources, and many polluters on their boards to make equivalent efforts.

When we consider the other element in policy outputs, namely, water quality standards set by various state agencies, we find that the ratio of non-polluters to polluters on the governing boards produces the highest correlation coefficient of those identified here. Both law and resources — relatively important for the enforcement effort — seem to have little effect on standards. This data suggests that there may be two different processes at work in this policy field, producing two different types of policy outputs. Certainly the lack of correlation between standards and enforcement effort points up the absence of proof that enforcement of pollution control laws occurs as diagrammed in the original model.

Measuring Impact on Environment

Despite the failure to explain successfully the process by which pollution control laws are enforced, an attempt was made to determine which, if any, of the factors identified thus far can be associated with the level of water purity in the various states. As might be expected, the fairest method for comparing different states' water quality is a hotly debated issue among personnel involved in water pollution control work. As critics of comparisons have pointed out, it is unfair to compare absolute levels of water purity between two or more bodies of water at the same point in time, because factors extraneous to the enforcement process are so often important in determining the quality of water. Thus it would be unrealistic to compare the temperature or dissolved oxygen level of a shallow lake located in a highly industrialized city with that of a swiftly flowing mountain stream miles from human habitation. Consequently, all comparisons were made between the quality of water at the same location from one time period to another. In other words, the measure of impact on the environment was relative improvement or degradation of the same water source over the same time period, rather than absolute water quality in two different locations. Since this study was designed to measure the enforcement efforts of states in the 1960s, the base year chosen to begin the comparison was 1960. All measures available in the months from June through September — when water quality is at its worst, if waste treatment measures are not increased — were considered.[8]

Four of the six parameters included in the water quality standards were utilized for this purpose: water temperature, dissolved oxygen, dissolved solids, and coliform count. These parameters were chosen not only because they are commonly recognized by experts as indicative of the relative degradation of water, but also because they are most often recorded by agencies involved in testing water quality. The three measures representing the worst water quality for each parameter (high readings for temperature, dissolved solids, and coliform; low readings for dissolved oxygen) were recorded, and the mean was calculated. This mean represented the low average of each of the four parameters for the summer of 1960. The same type of calculation was performed for the summer of 1968.[9] The two scores were then subtracted from each other, and the percentage of improvement or degradation was obtained. These percentages were then summed for all four parameters for all

rivers and/or lakes for which it was possible to obtain data, and a final positive or negative measure of water "improvement" was created. Comparison of the relative improvement of actual water quality over the nine year period with factors already identified with the administrative process for controlling water quality resulted in the following correlation coefficients:

FIGURE 4

	Law	Resources	Interests	Standards	Enforcement
Water Quality	.01204	.02915	—.02496	.19052	—.45913

While standards are correlated positively with actual water quality, the strongest correlation is a negative one with enforcement effort. When the values are grouped into high, medium, and low categories, and a contingency table produced, the relationship is reduced somewhat, but still present.

FIGURE 5

		Enforcement Effort			
		Low	Medium	High	
Water Quality Change	Low	2 (14.3%)	5 (33.3%)	7 (50.0%)	14
	Medium	5 (35.7%)	5 (33.3%)	5 (35.7%)	15
	High	7 (50.0%)	5 (33.3%)	2 (14.3%)	14
		14	15	14	43

If we accept the measure of water quality change from 1960 to 1968 as a true measure of the impact enforcement has had on the environment, we must conclude that the more effort made by states to enforce their laws, the worse the water is likely to become. Alternatively, however, we may choose to reverse the dependent and independent variables in this equation, and conclude that increasing degradation of water causes enforcement agencies to increase their administrative efforts. The latter interpretation has some merit to it, since the measure of enforcement effort was taken in one year (1969) at the end of the period during which water quality change was measured. The positive correlation between water quality and standards could also be explained in this manner, as the strictness of standards may very well be influenced by the degree of purity that existed at the time the standard was set.

Other Environmental Factors

There are in addition to actual water quality any number of factors which might be legitimately included in a descrip-

tion of the environment. These range from physical to social, economic, and political factors. But in a study of this size only those which appear intuitively to be the most closely linked with water quality and attempts to regulate it can be included.

As was mentioned briefly in the discussion of changes in water quality, there is considerable resistance to comparing states' efforts in pollution control because of differences in the magnitude of the problem which each faces. It is argued that any state with a small population and little industry spread over a large area with an abundant water supply will be forced to expend less energy on water pollution control than will a densely populated, highly industrialized state with little water. In order to determine whether the size of the problem each state faces can in fact explain differences among them in public policies on the subject, a method of measuring the magnitude of the problem was created.

Although there are many more sources of pollution than simply people and industry, for all practical purposes these are the two sources on which most anti-pollution agencies have concentrated their efforts during the history of legislation on the subject. Therefore, the measures selected were the 1970 total state population and the value added by manufacturing in 1967.[10] Since the value added by manufacturing exceeds the population in absolute numbers, the former figure was reduced to units of $1,000. Thus, the potential wastes from each individual living in the state over a year's time was assumed to approximate the potential waste produced in the course of adding $1,000 value to an item in the manufacturing process.[11] The volume of water available for waste disposal and all other uses was measured by the square miles of inland water present in each state.[12] The measure of water resources was divided into the total potential waste production (from population and industry) to give a figure representing the number of units of potential waste per unit of water.

Whenever pollution control is debated as a public policy, it becomes evident that specific "interests" may be easily defined. While not all such interests are organized, and many would have to be considered "latent," the fact remains that many people have strong opinions on the subject of pollution control. "Pro-pollution" forces can be defined as individuals and organizations with a primary interest in using the available water supply for waste disposal.[13] These persons include elected and administrative officials from cities and towns, in-

dustrialists, farmers, and anyone else who has been accustomed to using water for waste disposal and who views any governmental check on such use with alarm. Their testimony before legislative bodies, rather than being overtly pro-pollution, consists of arguing for "voluntary compliance" on the state level and "state autonomy" at the federal level. Generally they do not favor any increase in the law's strictness at any level. Normally, however, they are not groups specifically created to prevent pollution control policies from becoming law. Often they may be represented by trade organizations which originally organized for very different purposes. Consequently, in order to obtain some measure of the relative strength of such latent pro-polluting interests in each state, the total personal income from all sources was divided into the combined income produced by the construction, farming, mining, and manufacturing industries.[14] This produced a figure representing the percentage of state income which polluting activities account for.

Despite their relative unimportance to the entire state's income, economic interests with an obvious need for water quality to be improved, or at least not degraded further, were measured. In addition to the weight such economic interests may exert on water pollution control policy in each state, there are other interests which are normally represented in public debates on the issue. These are either private individuals or groups who claim to speak for persons who want to use waterways for recreation. Consequently, an index was constructed which combines both economic and non-economic anti-pollution interests.[15]

After identifying and measuring interests on both sides of the water pollution control controversy, an effort was made to measure some connective link between the rather amorphous politico-economic environment and anti-pollution laws and enforcement. The branch of government most commonly believed to represent a link between the entire electorate and public policy is the legislature. Consequently, a measure of legislative interest in the subject of water pollution control was developed.[16]

Independent and Dependent Variables Compared

When the scores for the dependent variables already identified and those for three independent and one linking variables were compared, the following correlation coefficients were obtained:

FIGURE 6

	Legis. Interest	Law	Re-sources	Interests Board	Stand-ards	En-force-ment	Water Quality
Legis. Interest	1.0000	.1389	.3686	.2244	—.0279	.4864	—.3803
Magnitude of Problem	.3551	.1692	—.0873	—.0627	—.0169	.3397	—.3824
Polluting Interests in State	.4747	.2967	.1808	.2140	—.1181	.4719	—.2958
Anti-poll. Interests	.1061	—.1913	—.0312	—.1138	.2789	—.1343	.1822

From these correlations, we find that the interest exhibited by the state legislature in water pollution seems to be only slightly correlated with the actual strictness of law as ultimately drafted. The interest shown by legislators correlates more strongly with three other dependent variables, including the enforcement effort made by the administrative agency. This is demonstrated when we look at the contingency table between grouped values of legislative interest and enforcement effort.

FIGURE 7

		Legislative Interest: Low	Medium	High	
Effort Enforcement	Low	9 (56.3%)	6 (33.3%)	1 (6.3%)	16
	Medium	4 (25.0%)	8 (44.4%)	5 (31.3%)	17
	High	3 (18.7%)	4 (22.2%)	10 (62.5%)	17
		16	18	16	50

Some reasons for positive correlations between legislative interest and all these dependent variables may be given. Since the law often determines the ratio of polluting and non-polluting representatives on the governing board, it is logical to assume that legislative interest will correlate with a preponderance of non-polluters on the board. It does not explain why other aspects of the law, as measured by the strictness of the law, do not correlate as highly. The legislature also determines how many of the state's resources will be allocated to different functions, and this explains the correlation with resources expended and legislative interest. The high correlation between interest and enforcement effort may in fact be due to this very intervening variable—resources expended. When we control for resources, however, we find that the correlation of .4864 has been reduced only slightly, to .4206. Therefore, we must conclude that, despite the relatively slight correlation between interest and law, it would appear that the overview which the legislature

keeps of the administrative agency may influence the latter's actions more than the law itself does. The casual model of legislative interest creating a law, which in turn affects enforcement effort, has not been borne out by this research. Rather, some less obvious effect of legislative interest on the administrators' attitudes toward their function may in fact be taking place. This is not to suggest that the individual legislators intervene directly in the administrative process, but rather that the consciousness which administrators have of the interest of the legislative branch of government in their function may influence their own actions.

The next row of coefficients concerns the magnitude of the problem. Only two, legislative interest and enforcement effort, would seem to be correlated positively, a fact which suggests that magnitude of the problem may in fact be causing the correlation between interest and enforcement as well. When magnitude of the problem is controlled for, however, the correlation of .4864 is only reduced to .4160, again indicating that the correlation between legislators and administrators is real and not spurious.

When we consider polluting and anti-polluting interests and their correlations with dependent variables, we are in for a surprise, for the presence of polluters correlates positively with legislative interest, strictness of the law, resources expended, and the makeup of the policy board. In the case of policy outputs, polluting interests seem to have, if anything, a negative effect on the strength of standards, but a high positive correlation with enforcement efforts. This is borne out by the following contingency table.

FIGURE 8

Polluting Interests

Enforcement Effort	Low	Medium	High	
Low	10 (58.8%)	5 (29.4%)	1 (6.3%)	16
Medium	3 (17.6%)	9 (52.9%)	5 (31.3%)	17
High	4 (23.5%)	3 (17.6%)	10 (62.5%)	17
	17	17	16	50

Since polluting interests in a state might be logically equated with magnitude of the problem, it is important to control for the latter factor in order to see whether the relationships still hold. In some cases, these positive correlations are reduced somewhat, but neverthless remain. In others, they increase:

Controlling for Magnitude of the Problem						
					Stand-	Enforce-
Polluting	Interest	Law	Resources	Board	ards	ment
Interests	.3864	.2487	.2582*	.2865*	—.1262	.3720

*increases

Clearly magnitude of the problem is not merely a surrogate for polluting interests in the state, and cannot be used to explain why polluting interests should correlate with both legislative interest and enforcement efforts. Despite the clear position polluting interests have taken against strict legislation and enforcement, it is obvious that they have not had the commonly assumed effect on either the strictness of the law or on the enforcement effort made by state agencies. While the high positive correlation with legislative interest may be explained by the notion that laws can be debated often and amended in order to weaken as well as to strengthen them, the positive correlation with strictness of law belies this explanation as well.

When we consider the anti-polluting interests and their correlations with other factors, we find that they, too, are not predictable. For the most part correlation coefficients are small and in the opposite direction from what is commonly assumed. The only encouraging signs from the point of view of interests who hope to affect the policy-making process of their states is that water quality standards are set higher in states with more anti-polluting interests. The positive correlation with standards and corresponding lack of correlation with enforcement would seem to give some evidence to the suggestion that some groups get symbolic rewards from the political system more often than they obtain substantive ones. The presence, therefore, of numerous outdoors enthusiasts at public hearings may influence administrators to create relatively high standards, but such standards seem to have little association with actual enforcement procedures.

When we turn to the final dependent factor, water quality improvement or degradation, we find that not only does a larger problem correlate with more degraded water, but also that greater legislative interest correlates with worse water quality. In the case of interests, however, we find results more in harmony with our expectations. Polluting interests appear to be correlated with more rapidly deteriorating water, whereas states with greater anti-pollution forces seem to be losing their clean water less quickly. When we group our data, we find the relationships between water quality and interests in the states have become even greater.

FIGURE 9

Anti-polluting Forces

Water Quality	Low	Medium	High	
Low	8 (57.1%)	1 (6.7%)	5 (35.7%)	14
Medium	3 (21.4%)	9 (60.0%)	3 (21.4%)	15
High	3 (21.4%)	5 (33.3%)	6 (42.9%)	14
	14	15	14	43

FIGURE 10

Polluting Forces

Water Quality	Low	Medium	High	
Low	2 (13.3%)	7 (43.8%)	5 (41.7%)	14
Medium	5 (33.3%)	5 (31.3%)	5 (41.7%)	15
High	8 (53.5%)	4 (25.0%)	2 (16.7%)	14
	15	16	12	43

We can attempt to decide whether the correlations between quality of water and independent factors are spurious by controlling for the magnitude of the problem. When this is done, the following correlation coefficients remain:

Controlling for Magnitude of Problem

	Interest	Polluting Interests	Anti-polluters
Quality of Water	—.2560	—.0920	.1577

The most striking feature of this table is that, unlike the case of correlations with enforcement effort, polluting interests' correlation with quality of water has almost disappeared when we control for magnitude of the problem. As was suggested earlier, the change in quality of water over the 1960s probably does not belong at the end of our model at all, but rather at the beginning, since it seems to serve the same function as magnitude of the problem: it *creates* legislative interest, enforcement effort, etc. Degradation of water over the past decade may have created a demand that legislative interest and recent administrative action is responding to. Deteriorating water quality may be helping to create an enforcement effort, but any improvement in water quality as a result of that effort will have to be observed in the future.

While it was originally hoped that this research would afford some evidence of the impact our public policy has had on the physical environment, this research has been more productive in demonstrating initial linkages between the environ-

ment (including the physical) and the policy process itself. It is, neverthless, important to know whether the legal framework, as we know it today, can in fact make an impact on the physical, social, and economic environment which legal scholars have designed it to affect. While the evidence developed in this research project is, to say the least, inconclusive, it is important to continue the search for such evidence through the use of longitudinal data after a sufficient amount of time has elapsed. If indeed the policy process does not work as we have assumed in the past, it is even more urgent that we develop some method of determining which are the relevant variables which affect the policy process from the environment and whether we can hope to affect the environment by our formalized processes.

APPENDIX A

Strictness of Law Index

After an initial assessment of the hypothetical process by which states hope to effect water pollution control, it was possible to identify nine powers essential to that process which are contained in the model law. These powers give the states authority to: 1) develop comprehensive water pollution control plans; 2) set individual water quality standards for lakes and streams; 3) hold administrative hearings in order to investigate actual water quality; 4) issue general and specific orders to abate conditions resulting in water pollution; 5) issue emergency orders circumventing the hearing procedure when conditions (such as a threat to the public health) warrant them; 6) review plans for proposed waste disposal plants; 7) issue, refuse, and/or modify permits for such plants; 8) inspect ongoing operations in established plants; and 9) administer federal grants given to municipal authorities for abating pollution.

In addition, two powers not specifically outlined in the model law, but mentioned often in individual state laws, were considered important enough to be considered major powers, namely, the powers to: 1) supplement federal financial assistance for constructing municipal waste treatment plants and 2) circumvent the necessity for a taxpayer's vote on raising municipal revenues for the city's share of those same plants. Only two state laws actually contain all eleven powers, but every state law contains at least two, and an index of strictness of law was created by assigning the same number of points (four) to each of the powers and adding the points which each state law thereby receives.[17]

The enumeration of powers, however, gives only one view of what is clearly a two-sided coin. Nearly all state legislatures which have adopted many of the suggestions contained in the model law have also deviated from this model by creating in their own laws particular weaknesses that, in effect, reduce the impact of the original powers. None of these caveats is included in the model, and their variety constitutes a testimonial to the creativity of the legislators involved. It is, therefore, impossible to list them; they range from admonitions to the enforcement agency to take into consideration any economic hardship its orders may create for suspected polluters to specifically exempting particular industries (such as sand and gravel washing operations) from all provisions of the law. Two points were subtracted for each exception to the eleven powers.

In addition, four other matters taken up in many state laws were assigned points. Most water pollution control laws now begin with a policy statement including a list of what the state officially considers to be legitimate, beneficial uses of the water supply. Others, without policy statements, mention legitimate uses of water in their definition of water quality standards. These uses can be divided into essentially polluting and non-polluting uses. The former include agriculture, waste assimilation, power production, mining, and other industry; the latter, propagation of fish, recreation, and aesthetics. In order to obtain a composite score, the negative (polluting) uses were subtracted from the non-polluting ones. Secondly, most states make provision for the attorney general to represent its anti-pollution agency in court; four points were awarded for a commitment to assist in all legal matters and two points for the power to sue only for injunctions or when a violator appeals an action. Thirdly, if a state provides some kind of tax break for industry, such as rapid amortization of treatment facilities, two points were assigned.

Finally, the strictness of penalties mentioned for the crime or misdemeanor of polluting water and/or disobeying agency orders was reviewed. Fines range from $100 to $10,000 and from one to six points were assigned for the size of the fine. Many laws have an additional provision that each day during which the violation continues constitutes a separate offense. Three points were given for continuing the fine at the same rate; two points for continuing at a lesser amount. Some laws stipulate that polluters pay the state for any wildlife destroyed, and this provision was given one additional point. Prison terms

range from thirty days to five years and were given from one to three points. All four measures of the penalties were added together and used, along with the other measures already discussed, to produce a composite score of the relative strictness of each state's law.

APPENDIX B

Resources Index

Two initial measures of state resources devoted to water pollution control work were developed. First, the total state budget for the fiscal year 1969 was divided into the amount expended by the anti-pollution agency that same year. (The fiscal year 1969 was selected for this data collection in most instances in this study, because 1) this was an effort to obtain an overview of the 1960s, and 2) 1969 was the year for which most data was available). Second, man-years devoted to water pollution control work were divided by the total number of state employees for the same year.

Since 1956, however, the Federal Water Quality Administration has had authority to award grants to states for use in their enforcement program, and federal funds constituted a part of each state's budget for water pollution control work in fiscal year 1969. It was, therefore, necessary to calculate the percentage of funds devoted to such work that came from the state's own treasury in order to measure the importance given to this subject. The formula by which the size of each state's grant is determined, like other federal grant programs, depends partly on state size and partly on its level of affluence; hence, the percentage of their own money which states devote to water pollution control work may be divorced somewhat from their interest in the subject. Nevertheless, most states overspend the amount required for them to be eligible for their share of federal funds each year. Another measure of the state's willingness to spend for water pollution control, therefore, is obtained by the following formula:

$$\frac{S-R}{R}$$ in which,

S = the amount spent by the state in fiscal year 1969

R = the amount the state had to spend to obtain its full grant

In order to combine all four measures of the state's relative interest in expending resources and water pollution control enforcement, a factor analysis was performed[18] and one principal factor was extracted.

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APPENDIX C

Water Quality Standards Index

One method of comparing standards is to consider their relative complexity. The first step in measuring complexity was to count the number of different classifications of water quality which each state agency created and to which it assigned numerical values.[19] Two points were assigned for each class so identified. Second, the number of different water quality parameters for which each state assigned quantifiable limits was considered. There are, of course, many measurable physical parameters which may merit inclusion in some states' standards, ranging from water temperature to the kinds of biota found in the lake or stream. Of these, six parameters recognized by most authorities as highly significant when testing water quality for a variety of uses ranging from public consumption to industrial cooling were chosen for inclusion: temperature, dissolved oxygen content, pH range, dissolved solids, coliform and fecal coliform counts. Two points were given for each of these parameters mentioned in the standards.

It is possible, of course, to establish an upper (or lower) limit for each of these six parameters for every category of water quality defined by the standards. This is very seldom done, however, as some of the parameters are considered relevant to only certain types of uses to which the water may be put (e.g., coliform count for water used for human consumption or water-contact sports). It was considered important to determine how many times the state agencies saw fit to mention each of the six major parameters, however, and the number of different values assigned to each of the parameters was recorded. Fourth, the number of trace minerals, such as arsenic, for which the state set numerical limits in any water classification were counted. The scores given for each of these four aspects of complexity were summed to obtain a composite score for the complexity of water quality standards.

In addition to complexity, it is also important to consider actual limits placed on these same six parameters. They do not all bear the same relationship to good water quality. For temperature, dissolved solids, coliform and fecal coliform, high readings are generally associated with degraded water conditions. For dissolved oxygen, the opposite is true: the more oxygen, the higher the quality of the water. The degree of acidity or alkalinity of the water, as measured by the pH

reading, is considered worse the farther from the neutral reading of 7.0 it gets. Therefore, the water quality limit is expressed in terms of width of the pH range: the wider it is, the more degraded the water may become. For each of the six parameters the highest value required by each state was recorded separately from the lowest value allowed. Points were given both for the strictest limits placed on the best water available in the state, and for the least strict limits placed on the worst water for which the state chose to create standards. The points assigned in each case ranged from one to seven and depended on the range of limits established by all fifty states. In addition to such across-the-board comparisons of loose and strict standards, comparisons were also made of the limits placed by states on water being used for the same purpose. Three uses assigned to water by most states, i.e., public water supply, water-contact sports, and fish and wildlife propagation, were identified. The limits assigned by each state for each of the six parameters were given points depending on where they fell in the range of limits among the fifty states. In cases where the particular parameter was not mentioned by the state for that use, no points were recorded.[21]

The Federal Water Quality Administration has state water quality standards under constant review, and as of October, 1970, it had identified four different levels of approval of the standards: 1) fully approved with an anti-degradation statement; 2) fully approved without such a statement; 3) partially approved with the statement; and 4) partially approved without such a statement.[22] Five and four points were assigned to the first two categories respectively, and two and one points to the latter two categories.

Four separate methods of measuring the strictness of the various states' water quality standards have been identified: 1) by complexity of standards; 2) by the best and worst limits placed on each of six parameters; 3) by the absolute limits placed on each of the same six parameters for three different uses; and 4) by the level of approval of the standards by the federal government. In order to collapse these four measures, a factor analysis was performed, and the single principal factor scores were obtained for all states and used as a composite score for water quality standards.

APPENDIX D

Enforcement Index

Three measures of enforcement are the percentages of treatment plants in each state which came under the permit, operating report, and inspection programs of the anti-pollution agency in fiscal year 1969.[23] The frequency of such reports and inspections also vary from state to state, however. Inspections range from an "emergency only" basis to a monthly schedule, with most states making them on an annual basis. Points were assigned for this element of enforcement, ranging from 0-25, in accordance with the following schedule:

none	ad hoc	annual	twice yearly	quarterly	six times per year	ten times per year	monthly
0	5	10	15	20	22	24	25

Intervals at which operating reports are required from water uses by state agencies range from none to weekly, and the following values were assigned to the various reporting schedules:

none	ad hoc	annual	quarterly	monthly	weekly
0	3	5	10	20	25

For most states, there exists an additional check on the operating report procedure, i.e. validation through an effluent analysis run by the state agency itself, and 25 additional points were awarded for the existence of such a check.

In addition to the three main methods of overseeing the operation of waste treatment plants, a fourth and less direct type of safeguard is for the water pollution control agency to reassure itself about the competence of the operators of such plants. Many states now have instituted a certification program whereby treatment plant operators are given standardized tests in order to measure their understanding of principles common to most waste treatment methods. This fourth administrative procedure is not so widespread in its application as to allow estimates of the percentages of operators under certification in most states. Therefore, it is necessary to assign points for the type of system which is in force in each state. The following chart summarizes the scoring method:

	Mandatory	Voluntary	None
Operators			
Municipal	20	10	0
Industrial	20	10	0
Other	10	5	0
	50	25	

It is possible, however, that a state agency may go through all the steps outlined above and find that all (or some) of its

waste treatment plants under permit are achieving results below those required by the permits. The legal recourse is the authority of the responsible agency to issue orders requiring that better results be obtained either through the installation of new equipment or improvement in operation of the old. In most states, the enforcement order is seldom used, but since it does remain the ultimate sanction for all states, a ratio of orders to total number of treatment plants in the state of fiscal year 1969 was calculated. These eight different measures of enforcement were also reduced by factor analysis to a composite score for the strictness with which the water pollution control act is enforced in each state.

APPENDIX E

Anti-Pollution Index

Two measures of economic anti-pollution forces were obtained. First, the value of fish caught by commercial fishermen (who are the most vociferous in their testimony against such polluters of bays and estuaries as paper manufacturers and oil refineries) was added to income earned by sport and recreation camps. These combined figures were divided by the total amount earned by all businesses in the state in 1967. Second, the percentage of all retail sales represented by sporting and outdoor recreation equipment sales was calculated.[24] Three separate measures of non-economic interests in clean water were selected. First, the percentages of people who hunt and fish in the state were calculated by dividing the 1970 population into the number of hunting and fishing licenses issued in 1968. Second, the number of visits to state recreation facilities in 1962 were divided by the state's 1960 population.[25] Third, the number of members claimed by three organized groups who have frequently made their stand toward water pollution control known — the Audubon Society, the Izaak Walton League, and the Sierra Club — were divided by the total state population.[26] All five measures of anti-pollution forces were then factor analyzed to produce a composite score for each state.

APPENDIX F

Legislative Interest Index

State anti-pollution legislation has had a checkered history.[27] Some laws on the subject have existed since the beginning of the twentieth century; other states waited until action

at the federal level forced them to take action by threatening to seize the initiative in this field unless the states assumed responsibility for water pollution control. The first measure of interest demonstrated by state legislatures is the year in which the state created its first water pollution control law. Since these dates range from 1898 to 1967, it was necessary to group them into categories and assign points. Six to ten points were given states which created their own laws before any federal legislation existed in this field, with an additional point given for every eight-year period beyond the minimum. Four or fewer points were assigned for laws created after 1948 and fewer points were given after each year in which a major federal amendment tightening restrictions on water pollution at the national level was passed.

In addition to promptness in legislation, state legislatures exhibited their continuing interest by passing amendments to the original laws. Each separate year in which such changes were successfully completed was given a point. Finally, the recency of the latest amendment was considered, with five points assigned for amendments through 1970, and none given to any state whose legislature has been silent on the subject for ten years or more. The points created in this manner were cumulated and a composite "legislative interest" score was obtained.

FOOTNOTES

[1] Adapted from Easton (1965).

[2] See Appendix A for a description of this index.

[3] See Appendix B for a description of this index.

[4] A considerable portion of the debate over federal water pollution control legislation passed in the last 20 years has been devoted to arguments over the merits of placing the administrative agency inside different parts of the executive branch. And, in fact, the agency has been variously situated in (1) Health, Education and Welfare; (2) the Department of the Interior; and (3) an independent agency (the Environmental Protection Agency) created in 1970.

The overriding argument in Congress at the time of the first move was the people concerned with chlorinating water to a drinkable condition (public health officials) were not sufficiently interested in water in its natural state. The second change came after arguments were heard that no agency with a vested interest in exploiting natural resources could be trusted to improve the condition of one such resource.

[5] See Appendix C for a description of this indx.

[6] See Appendix D for a dscription of this index.

[7] Correlation coefficients and cross-tabulations were run on a CDC 6400 at the University of Washington computer center, using a program from: *Statistical Package for the Social Sciences* (Nie, Bent, and Hull, 1970). Since the location of the administrative agency in the state government can be measured only in terms of a nominal scale, and the presence or absence of policy-making and advisory boards is a dichotomous variable, these two factors cannot be included in this table.

[8] The source of all data on actual water quality was the Federal Water Quality Administration (forerunner of the Environmental Protection

Agency) in Washington, D.C. Several qualifications concerning this data must be made. First, the federal government has been empowered to operate a nation-wide system of water quality testing stations since 1956, and most of this data comes from that source. It is, of necessity, a thin system, widely spread over the entire United States. Only the largest rivers and lakes have been tested, in only a few locations. Therefore, data was available for only 43 states, albeit the largest, most industrialized, populated, and polluted states. In addition, the representativeness of the data varies from state to state. For some states there was sufficient data to make comparisions at only one location on one river; in others, as many as seven different stations had sufficient data for these comparisons. Because of the need to obtain longitudinal data, only those stations which had been in operation since 1960 could be included, and lack of data for specific parameters in the appropriate years often caused the loss of other states.

An effort is now being made to include data collected by state agencies through their own monitoring systems in the STORET system in the E.P.A. However, participation varies from state to state. In the future, it may be possible for more complete comparisons to be made. At the present time, the federal government has published none of this data. While I wish to acknowledge my indebtedness to the F.W.Q.A. for making this data available to me, I wish to make it clear that it was given me in a raw state, and the use (or misuse) to which I have put it is my own.

[9] The year 1969 was not used because of lack of data for many states.

[10] The latest census figures were used rather than 1960 ones because it was felt that actual numbers of people in 1970 gives a more accurate picture of the problem faced by pollution control agencies in the decade of the 1960s when some states were experiencing a large increase in population and others remained static.

Value added by manufacturing was obtained from the Bureau of the Census (1970b: 699). This figure varies from year to year, as does population. The latest available figure was selected for inclusion for the same reason that 1970 census data was used.

[11] Clearly these are very approximate figures, as each manufacturing process produces a different amount and strength of wastes. However, it was not feasible for the types of industry present in each state to be controlled for.

[12] These figures also come from the Bureau of the Census (1970b: 166). They include all permanent inland water surfaces; lakes, reservoirs, ponds having 40 acres or more area; streams, sloughs, estuaries, and canals ⅛ of a statute mile or more in width; deeply indented embayments and sounds, and other coastal waters behind or sheltered by headlands or islands.

[13] The pro-pollution forces are more generously identified in the literature as "water users," but this term is deceptive, as all individuals involved in the controversy are in fact water users. They simply differ on what use the water can best be put to. Anti-pollution forces contend much water should be reserved for such uses as recreation, whereas pro-pollution forces make the traditional "multiple use" argument, which they contend would get the maximum economic utility from all water.

[14] These figures come from the Bureau of the Census (1970b: 318-319). These four industries were selected because they have all been cited as major producers of pollution, and all states have indicated some desire to control their waste disposal. All have also been present in the councils of government arguing either against all regulation of pollution or for the proposition that their contribution to it is small in comparison with the whole problem. While labor unions sometimes appear on the side of anti-pollution forces, when a crisis is reached on the local level, industry is quick to argue that they will be forced out of business if they comply with anti-pollution regulations. This is normally taken as a real threat by individual workers, and consequently all income from any such industry represents an interest in eliminating controls if a crisis is reached.

[15] See Appendix E for a description of this index.

[16] See Appendix F for a description of this index.

[17] One exception to the assignment of four points was made. A sliding scale was necessitated in the case of the power to provide state funding for municipal treatment because of varying approaches to this problem.

Some states have only reached the point of providing legislative authority for such funding; others have already appropriated money for the purpose. Two points were assigned for the authority and two additional points for the appropriation. Some states have produced half a loaf by providing for state loans, rather than grants, for which they are credited with one point each for legislative authority and for funding. In addition, a few states now advance the federal portion of a grant to a municipality when federal money is slow in arriving, and this authority is also given one point, with an additional one for funding. This scale results in a possible score of eight points for all aspects of state funding, but few states qualify in all categories.

[18] Factor analyses for this study were computed on a CDC 6400 at the University of Washington using a Biomed program with orthogonal rotation.

[19] A neutral score of zero is obtained: 1) when the polluting and non-polluting representatives are equal in number and 2) when only government employees sit on the boards.

[20] Unknowns are indicated whenever there is no stipulation in the law concerning the types of interests to be represented or when the description of the persons to be selected is too vague to allow classification as polluting or non-polluting.

[21] Water quality standards were obtained from the various state water pollution control agencies, and from the Water Quality Standards Division of the Federal Water Quality Administration.

In order to qualify as a water quality class, it was necessary that there be designated for at least one parameter an upper or lower limit, as measured in quantities normally used to test water quality. Such narrative descriptions as "free from floating debris and scum" were considered too vague to represent an enforceable standard.

[22] This procedure was complicated by the fact that not all states have created standards based on uses of water. In some cases, estimates had to be made on the type of use any given water quality criteria were supposed to apply to.

[23] A non-degradation statement indicates that in cases where the actual water quality exceeds the standards set for it, the water will not be allowed by the state to become degraded to "meet" the standards. It has been actively encouraged by the Federal Water Quality Administration.

[24] These figures, as well as other data concerning state enforcement programs, were obtained from the Federal Water Quality Administration (1970).

[25] The value of fish caught comes from the Bureau of the Census (1970: 635). Other figures were also obtained from the Bureau of Census (1970a). This is the latest such census available.

[26] Hunters and fishers were obtained from the Bureau of the Census (1970b: 202). Visits to state recreation facilities come from the Bureau of Outdoor Recreation (1963). This survey was conducted in 1962 and has not been repeated since that time.

While it is true that both hunters and fishers, as well as persons using recreation facilities, are not necessarily restricted to residents of the state, no attempt was made to separate them from out-of-state vacationers. While not all residents view such visitors to their state as a blessing, they are in fact a source of income to a segment of the state's population and should, therefore, represent an additional economic incentive to maintain high water quality.

[27] These figures were sent to me by the organizations in question.

[28] This information was obtained during the initial review of all state legislation on water pollution control.

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