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Demographic change and fisheries dependence in the northern Atlantic

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Abstract

Northern Atlantic fisheries have experienced a series of environmental shifts in recent decades, involving collapse or large fluctuations of the dominant fish assemblages. Over roughly the same period, many fisheries-dependent human communities have lost population, while their countries as a whole were growing. Population loss tends to increase with the degree of fisheries dependence, among communities and sub-national regions of Newfoundland, Iceland and Norway. A close look at Norway, where municipality-level data are most extensive, suggests that population declines reflect not only outmigration, but also changes in fishing-community birth rates. Multiple regression using 1990 and 1980 census data for 454 municipalities finds that fisheries dependence exerts a significant negative effect on population, even after controlling for six other predictors including unemployment and income. The general pattern of changes seen in northern Atlantic fishing communities resembles those identified by migration research elsewhere. Fishing communities are unusual among contemporary first-world societies, however, in that rapid and large-scale environmental shifts appear to be among the forces driving population change.

Keywords: *fisheries, North Atlantic, environment, demography, population, migration, Newfoundland, Iceland, Norway*

Over the past one or two decades, diverse fisheries-dependent regions of the northern Atlantic have experienced strikingly similar patterns of demographic change. They have tended to lose population, even while their countries as a whole were growing. Along with population decline came a new demographic profile: the populations of many fishing communities were younger, on average, than the rest of their countries in the 1980s, but they are older than average today. Such changes reflect a variety of forces, some of them common to other types of rural or resource-dependent communities. But the details and timing of recent demographic changes suggest that environmental shifts in the North Atlantic have also been among the drivers.

The most visible manifestations of these environmental shifts have been declines in the abundance of cod and other demersal species that until recently were main staples of Atlantic fisheries. Cod populations off west Greenland and maritime Canada both collapsed in the early 1990s. The U.S. belatedly closed key fishing grounds off New England in 1994. Other crises affected Icelandic, Norwegian and Faroese fisheries. The large scale and human impacts of these events have inspired scientific and popular books, including Arnason and Felt (1995), Boreman et al. (1997), Candow and Corbin (1997), Chantraine (1993), Finlayson (1994), Hannesson (1996), Harris (1998), Jentoft (1993) and Kurlansky (1997). The collapse of commercial fish populations resulted primarily from overfishing, sometimes in combination with oceanographic variations. Although specific economic and management decisions have been faulted within each country, the ubiquity of fisheries crises identifies them also as a deep-rooted pattern of contemporary human ecology.

General trends towards declining mean trophic (food chain) levels have been documented for fisheries-influenced ecosystems of the North Pacific (Deimling and Liss 1994) and elsewhere (Pauly et al. 1998). As predatory fish are removed, an ecosystem and hence its fisheries can become increasingly dominated by other species that are closer to primary production. This trend has been prominent in the northwest Atlantic, where the depletion of cod and other predatory fish has been followed by a growing economic reliance on invertebrates (e.g. lobster, crab, shrimp, urchin). An overall downward shift in mean trophic levels can be shown for the northeast Atlantic also, with some exceptions in particular areas.

For fishing communities, marine-environment shifts bring economic ups and downs. Economic uncertainty and crisis-response policy changes then contribute to flows of outmigration. In this paper we begin by examining recent population changes, and their relation to fisheries dependence, within three principal northern Atlantic fishing cultures: Newfoundland, Iceland and Norway. We then focus particularly on Norway. Comparisons between 1980 and 1990 census data on more than 400 municipalities provide a portrait of demographic changes taking place in fisheries-dependent places. Finally, we explore whether fisheries dependence remains a predictor of population loss, after adjusting for other structural and economic factors. These analyses make use of community and regional-level data sets developed for research on Norwegian fishing communities (Otterstad 1993), and for a comparative study of North Atlantic fishing communities (Hamilton, Duncan and Flanders 1998).

Population and Fisheries Dependence

Conceptually, "fisheries dependence" is a continuous dimension, or several dimensions, and hence a matter of degree. For our purposes, statistics on the proportion of a place's labor force, employed persons, or actual labor devoted to fishing and fish processing, provide simple operational measures of the degree of fisheries dependence. Such statistics commonly are available at community and regional levels, permitting comparisons between many places within each nation. Formal cross-national comparisons based on community or regional data remain problematic, due to inconsistencies in the definitions and units of analysis employed by each country. Less formally, however, we can examine the extent to which similar relationships exist between corresponding variables, measured within each of several nations. This section explores the relationship between population change and fisheries dependence.

Using data from Statistics Canada, Figure 1 plots relative population change (1991–96) against the percent of the work force involved with fishing and fish processing in 1991. Each data point represents one of the 10 Census divisions in Newfoundland, Canada's most fisheries-dependent (and chronically poor) province. Demersal fish populations on Newfoundland's Grand Banks fishing grounds, once the world's richest, collapsed in the early 1990s and have not since recovered. Since a moratorium on cod fishing was declared in 1992, Newfoundland as a whole has been losing population — down 2.3% from 1993 to 1996, after a period of approximate stability 1983–92, and a steady increase of 28.6% over 1960–82. All 10 Census divisions show negative growth in Figure 1, but population loss increases with the degree of fisheries dependence (Pearson correlation $r = -.86$, t test probability $P < .01$).

Figure 2 shows a similar plot based on data from Statistics Iceland and Iceland's Rural Development Institute. The points here represent Iceland's 9 geographical regions. "Fisheries dependence" is measured as a proportion of the total man-hours worked. Unlike Newfoundland, where government subsidies support fisher folk, Icelandic fisheries must in large part support their government. Faced with the imperative to manage their key resource rationally, Icelanders have pioneered a management/social experiment called individual transferable quotas (ITQs). ITQs were initially proposed as a conservation measure, meant to solve the "tragedy of the commons," but much recent discussion has focused on their social effects (Pálsson and Pétursdóttir 1997). Quota shares command high market prices, which create both strong incentives for small-scale fishermen to sell out, and barriers to the entry of new fishermen. Over time, quota shares increasingly concentrate in fewer hands. This concentration can affect communities as well; the quota shares held in some ports increase, while in others some or all fishing rights have been sold away. The ecological consequences of ITQs — whether they in fact encourage conservation, or the opposite due to high-grading of catches — are another topic of debate.

Icelandic fishermen who remain active are adapting to environmental change by pursuing alternative species around

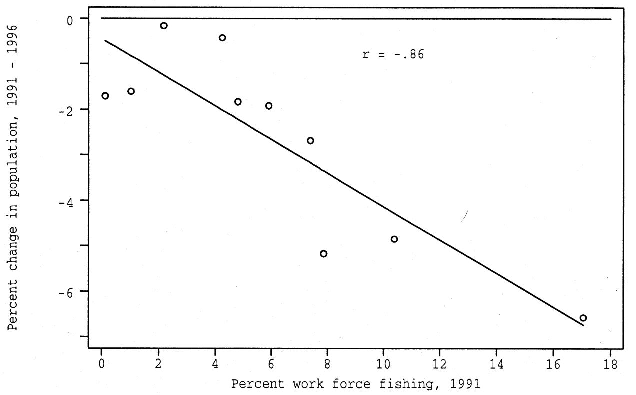

Figure 1: Population change (1991-96) and fisheries dependence among the 10 Census divisions of Newfoundland.

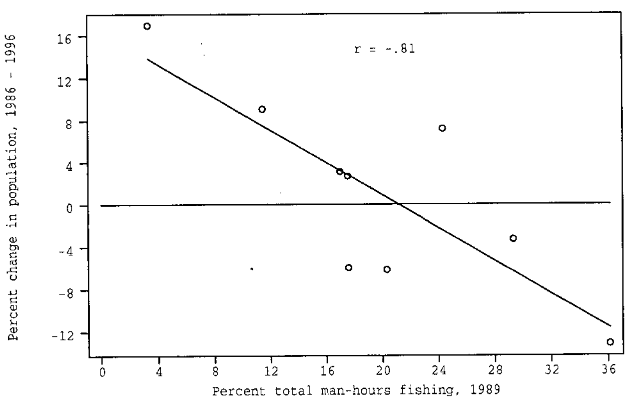

Figure 2: Population change (1986-96) and fisheries dependence among the 9 geographical regions of Iceland.

Iceland, and sending ships to distant waters in compensation for home-waters depletion. These efforts have maintained overall fishing-industry income, but have not stemmed the recent tide of migrants out of fishing areas, and into the capital region around Reykjavík. During 1986–1996, the population of Iceland as a whole grew by 10.4% — but most of that net gain occurred in the capital region, at top left in Figure 2. Low or negative growth rates occurred in the more fisheries-dependent regions ($r = -.81$, $P < .01$).

Both Newfoundland and Iceland are comparatively small island societies (560 and 270 thousand people, respectively), that in fundamental ways depend upon fishing. Norway, in contrast, is a nation of 4.4 million people, with a more diverse economy — boosted in recent decades by the windfall of North Sea oil. Fishing troubles therefore present a less general challenge to the Norwegian economy, but they still threaten the viability of many communities along the west and northern coasts. The Norwegian story illustrates the division between capital- and labor-intensive fisheries (typically, offshore and inshore) that exist within most fishing nations. It also shows how this division can interact with marine ecology.

Population declines in fishing-dependent Norwegian municipalities date back to the early 1960s, reflecting a series of postwar problems. Cod and herring are historically distinct Norwegian fisheries. Herring and other pelagic fish have been pursued primarily by vessels from west Norway. This fishery industrialized earlier, and consequently its catch sooner exceeded ecological production. Herring catches peaked in the mid-1950s, then suffered collapses in 1956–63 (for which the temporary solution was expanded deepwater effort based on a technological intensification, the power block) and again in 1968–72. Large increases in capelin landings compensated for the second herring collapse, but in the late 1980s capelin too declined.

The postwar coastal cod fishery in north Norway was initially more labor-intensive, and less capable of overfishing. Overall cod catches did not peak until the 1970s, but thereafter followed an erratic, gradually downwards course leading to a late-80s crisis. Strong catch limitations and deliberate capacity reductions, imposed to protect the resource, also created difficulties for fishermen. Government subsidies to support fishermen's incomes, begun in the 1960s but declining since 1980–81, briefly increased again during 1989–90 to cushion this crisis.

Thus for both pelagic (herring, capelin) and demersal (cod) fisheries, the 1980s were a period of troubles. Norwegian cod and spring-spawning herring catches increased in the early 1990s, although the most recent (1996–97) estimates suggest a cod population decline. Capelin and North Sea herring populations remain low. Among the human correlates of fisheries troubles have been difficulties in attracting young men to work in the fisheries, or in keeping young women in the fishing communities at all (Hamilton and Otterstad 1998).

Figure 3 graphs population change, 1980–90, against fisheries dependence of 19 Norwegian counties (data here and for Tables 1–2 from Otterstad, 1993). Compared with Figures 1 and 2, we see more scatter around the left side of the regression line in Figure 3, reflecting variations among the several Norwegian counties that have little fishing. An overall negative trend in Figure 3 is nevertheless clear ($r = -.60$, $P < .01$). All counties with more than one percent of their employment in fishing experienced low or negative population growth, during a decade when Norway as a whole grew by 3.8 percent.

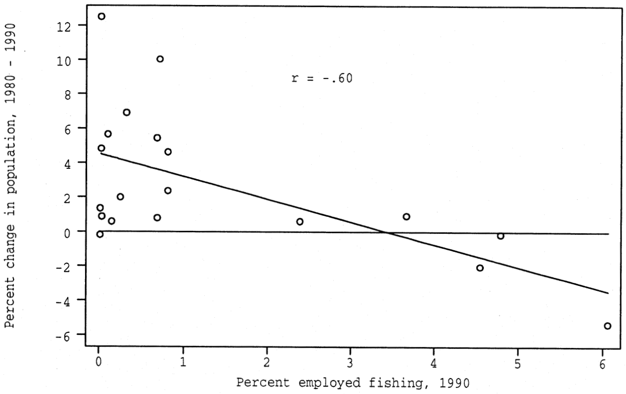

Figure 3: Population change (1980-90) and fisheries dependence among the 19 counties of Norway.

Population change, of course, is the sum of three flows: births, deaths, and migration. Outmigration provides the most obvious explanation for fishing-region population loss. It is not quite the whole story, however. The next section looks more closely at the demographic changes that took place in Norwegian municipalities during this decade.

Demographic Change

Large units of analysis provide a degree of comparability in Figures 1–3. For a clearer picture we need finer resolution, bringing our analysis closer to community level. Table 1 employs smaller-scale data on Norway, dividing 454 municipalities into two broad groups: 'fisheries-dependent' and 'other.' For this analysis, we classified as fisheries-dependent any municipality where at least 10% of employed persons in 1980 worked in the fishing industry. (Because municipalities are small units, many of them are fisheries-dependent to a higher degree than any of the whole counties shown in Figure 3.) Forty-eight municipalities met this criterion. The cut-point is arbitrary, of course, but the substantive conclusions from this table are not sensitive to the specific value chosen.

Table 1. Demographic changes in fisheries-dependent municipalities (at least 10% of employed persons in fishing, 1980) and other Norwegian municipalities

	Other municipalities (406)			Fisheries dependent (48)		
	1980	1990	change	1980	1990	change
Median population	4813	4865	+52	2100	1900	-200
Median growth			+1.2%			-10.0%
Percent ages 0-19	29.4	26.4	-3.0	32.3	28.2	-4.1
Percent ages 20-39	29.2	30.4	+1.2	26.8	27.7	+0.4
Percent ages 40-59	20.8	22.2	+1.4	19.9	21.3	+1.4
Percent ages 60+	20.6	21.0	+0.4	21.0	22.8	+1.8
Percent female 20-39	47.7	47.9	+0.2	44.7	45.7	+1.0
Median age, males	33.3	35.0	+1.7	32.3	35.5	+3.2
Median age, females	35.4	36.9	+1.5	34.1	37.2	+3.1
Median births/1000 females ages 15-49[a]	59.1	56.1	-2.9	66.8	58.5	-8.3
Percent with college education	9.0	16.2	+7.2	5.0	14.0	+9.0
Median income per taxfiler, in 1980 kr.	55.3	45.8	-9.5	47.3	42.3	-5.0
Percent unemployed	1.0	5.5	+4.5	2.0	8.8	+6.8

[a]1990 birth rates based on the number of females ages 15-49, and 1980 birth rates on females ages 16-49.

Table 1 confirms that fishing regions in general lost population, while the rest of Norway gained, over the years 1980–90. The proportion of children fell, and the proportion of elderly rose, to a greater extent in fisheries-dependent municipalities. Such places remained more heavily male than the rest of Norway, reflecting disproportionate female outmigration (a trend described half-jokingly by some residents as "The women leave, and the men follow"). Among both males and females, the median age patterns reversed: fishing communities were younger than the rest of Norway in 1980, but older by 1990.

Partly, this change in age structure reflects outmigration by young adults. Table 1 reveals a second element, however. The median age-adjusted birth rate was, in 1980, considerably higher for fishing communities than elsewhere in Norway. By 1990, however, the birth rate had fallen steeply, making fishing and non-fishing places more alike. Thus, population in the former declined not merely because people were leaving, but because outmigration was no longer being offset through fishing communities' previously high fertility. The youngest age group (0–19 years) in fishing communities shows the largest relative decline in Table 1: there are fewer children because fewer young adults remain to start families; and among those who do remain, fertility tends to be lower than before.

In several other respects, fishing communities also became more like the rest of Norway. In incomes and the human capital of higher education, fishing municipalities narrowed the gap, although they still lagged behind. With respect to unemployment, however, the disadvantage of fishing municipalities increased. This raises the question of whether unemployment, rather than fisheries dependence as such, might account for some of the observed population loss.

Predictors of Population Loss

The environmental shifts described earlier provide one set of reasons why livelihoods in Norwegian fishing communities have become more tenuous, and hence less desirable, in recent years.[1] Other characteristics of fishing communities also comprise "push" factors. For example, global competition and a widespread shift from labor-intensive to capital-intensive production (including offshore fish processing) made growing numbers of fisheries workers redundant. Furthermore, small fishing communities cannot offer the range of amenities, or educational, social and economic choices, found closer to urban centers. The range of job opportunities and social roles for women, in particular, appears limited in many fishing communities — even more so with the loss of fish processing jobs. These factors presumably act together to influence individual decisions. Given the presently available data, however, we cannot formally estimate the separate effects of different push factors within fishing communities.

The preceding explanations all look for the causes of outmigration in the characteristics of fishing communities as such. Alternatively, we might look beyond fisheries issues, and consider more general explanations. For example, the correlations between population change and fisheries dependence could reflect geographical, not environmental, factors. Fishing communities tend to be rural, or small in size, and perhaps small rural places are not preferred. In Norway, furthermore, fisheries dependence is most common in the north. North Norway's distance from metropolitan centers, narrow economic base and dark winters might cause it to lose population anyway, regardless of fisheries trends. We should also ask whether fishing-community declines are not simply one aspect of modernization: the shift of labor from primary to secondary and tertiary industries. Or perhaps other community characteristics — such as limited physical and human capital, or poor employment prospects — that encourage outmigration, just happen to be higher in fishing communities. These alternative explanations are compatible with some of the push factors mentioned previously, although they depict them as properties of rural places or resource-dependent communities in general, and not just of fishing communities. On the other hand, this class of explanations does not encompass marine-environmental factors, which uniquely affect fisheries.

Data on Norwegian municipalities permit us to test some of these competing explanations. Table 2 shows a multiple regression of 1990 population on 1980 population, fisheries dependence and other predictors.[2] With 1980 population included as a control variable, the coefficients on predictors in Table 2 can be understood as effects on relative change in population. Thus Table 2 shows that, other things being equal, population during this decade tended to increase with median taxpayer income, the percent of adults with higher education, and the percent of employed persons in primary-sector industries other than fishing. North Sea oil is the most important such primary industry, a mainstay of the Norwegian economy that helps to subsidize the less profitable fisheries (Hannesson 1996). Primary industry's positive coefficient indicates that fishing in particular, rather than primary or resource-extraction industry in general, is associated with population decline. Population tended to decrease as the percent of the workers in fishing increased, and also in the municipalities of north Norway. Adjusted for other variables in this model, unemployment rates had no discernable net effect on population.

These results support the view that population declines result partly from fishing communities' special character and experiences. Fisheries dependence exhibits a net negative effect upon population even after we adjust for six other predictors: community size, wealth, education levels, primary industry, unemployment, and location in north Norway. Although the coefficient on fishing dependence is statistically significant (P = .004), its actual magnitude is modest. If all other predictors remained equal to their respective medians, this coefficient implies about 75 fewer people with each 10-point increase in fisheries dependence. Dependence arguably exerts substantial indirect effects, however, which give it a total effect more than twice the size of this direct effect.[3]

Table 2. Robust regression of 1990 population (logarithms) on 1980 population, fisheries dependence and other characteristics of 454 Norwegian municipalities

Predictor	Coefficient	Std. error	*P*
Log_{10} of population 1980	1.0009	.0041	<.001
Fishing as percent of employed 1980	-.0008	.0003	.004
Median taxpayer income 1980	.0031	.0003	<.001
Percent with higher education 1980	.0014	.0003	<.001
Unemployed as percent of workforce 1980	.0002	.0011	.848
Percent workforce in primary industry (not fishing)	.0006	.0001	<.001
Dummy variable coded 1 for North Norway	-.0110	.0039	.006
(Constant)	-.1938	.0250	

Discussion

Studies of farming, logging and mining areas of rural North America have produced a wealth of empirically-derived generalizations about resource-dependent rural communities (e.g, Field and Burch 1988; Freudenburg 1992; Humphrey 1995; Luloff and Swanson 1990). Some of these generalizations fit Atlantic fishing communities well. Changes in human populations following changes in the resource base are typical of natural resource-dependent communities (NRDCs) in general. NRDCs tend to boom as resource-extraction activities expand, and subsequently to bust as resources get depleted, or marketing/production advantages shift. Field and Burch (1988, 38) observe that "Resource-dependent communities may be unique in that the primary production processes and changes therein have direct consequences for community stability." In the special case of fishing communities, the primary production process is the marine ecosystem itself, which must supply all the fish. Thus the linkage between environmental and social change should be particularly strong there. Like other NRDCs, however, fishing communities' vulnerability to resource change reflects more general problems: the weakness of backward and forward economic linkages, plus an historic underinvestment in human capital. Remoteness, as well as limited natural and human resources, add to their competitive disadvantages in the new global economy.

Rural-to-urban population flows are the classic subject of migration research, and contemporary Atlantic fishing communities conform to many of the classical patterns. Young people, especially those with more education, are the most likely to move. Their departure thus weakens the source communities, more than numbers alone might suggest. Motivations for individuals leaving fishing communities include a mix of push and pull factors, broadly resembling those identified for other rural areas by authors such as Lee (1966) and Bogue (1969) — for example, resource problems, loss of jobs, limited opportunities, and catastrophes in rural areas; better job and education opportunities or living conditions in urban centers. Ólafsson's (1997) surveys regarding community satisfaction and reasons for migration within Iceland yielded results broadly consistent with older studies from the rural U.S. and elsewhere. The excess of young women among fishing-community outmigrants presents a less universal pattern, although it has been observed elsewhere in the North (e.g., Hamilton and Seyfrit 1994). What makes Atlantic fishing communities most unusual, however, is not the nature of recent changes, but rather their timing and proximate causes. As Bogue (1969, 753) notes: “Whenever we observe population flowing out of an area or into others, we should suspect that a major social/economic change is going on.” In the case of the northern Atlantic fisheries, social changes are happening quickly, and large-scale environmental shifts are among their drivers.

Aging, declining populations bode ill for the future of small fishing communities. To maintain viable communities and avoid rising dependency, governments perceive an interest in halting these trends. We have seen that such trends are not merely national, but regional or global in scope; their causes are rooted at least partly in human ecology. Halting such trends through national policies will prove difficult. Governments could, however, make more room for traditional, labor-intensive fisheries by sacrificing some industrial, capital-intensive fishing — or vice versa. Either choice has serious political and economic costs, although not choosing will undoubtedly cost more. Within each sector, as well as in tradeoffs between sectors, overall fish catches will decrease either in a deliberate way through policy, or more chaotically through resource collapse.

Fundamental values are involved in the policy choices. The economic value of industrial fisheries and the employment value of traditional fisheries get the most attention in political discussions. Cultural diversity provides a different, more ecological reason for valuing traditional fisheries. The cultural variety that can be observed along the coasts is an historic reflection of human adaptations to nature, climate, local experiences, macro economics, policies and a range of other processes — observed almost as coincidences. Each community has followed its own particular path of adaptations. At any one time these communities together present a snapshot, or a shop window, displaying the variety of specific local adaptations. Viewed over time, there would be an interesting movie for each of them. For each community the results today are different. Some are success stories, others are continuous failures. And success in one period can prove to be a drawback in the next, when conditions change but people are reluctant to alter a winning strategy. For example, the most capital-intensive fisheries of the 1930s often were victims of bankruptcy some years later, and the small scale fisheries that survived those lean years fared poorly during later times of expansion.

Such cultural diversity comprises an adaptive resource in itself, capable of contributing to social systems in the same way that genetic and species diversity contribute to the flexibility of biological systems. The survival of traditional fishing communities has ecological importance, therefore, not as museums of the past, but as sources of information and possible models for the future.

Endnotes

1. Evidence favoring the importance, although not the singularity, of environmental explanations in other fishing regions comes from the timing of migration trends in Newfoundland, Greenland and the Faroe Islands (Hamilton and Haedrich 1998; Hamilton, Lyster and Otterstad forthcoming). Case-study interviews in Newfoundland and Maine provide additional lines of evidence (Duncan et al. 1998).
2. Populations were re-expressed here as base 10 logarithms to linearize relationships and reduce the leverage exerted by Oslo. Even in log form, distributions of population measures (and certain other variables) exhibited some outliers. Consequently we employed a robust regression technique (described in Hamilton 1992) for Table 2, rather that the usual ordinary least squares (OLS). This particular robust technique uses iteratively reweighted least squares to reduce the influence of *y*-outliers. Screening for unduly influential *x*-patterns is accomplished through a preliminary calculation of Cook’s D. Monte Carlo experiments support theoretical arguments that this estimator remains efficient, with unbiased standard error estimates, given even severely non-Gaussian (but independent and identically distributed) errors. For comparison purposes we also estimated the same model using OLS, and obtained an adjusted R^2 above .99 (robust regression itself does not yield an R^2 value). The OLS t tests lead to similar substantive conclusions, although OLS parameter estimates are less precise than their robust counterparts in Table 2.
3. An exploratory path analysis, not shown here, suggested that the indirect effects of fisheries dependence, through education and income, could be half again as large as the direct effect seen in Table 2.

Acknowledgments

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