Submission on changes to the number of members of the ACT Legislative Assembly.

Keith Helyar

My interests: I am a retired soil scientist with experience in modelling dynamic systems. I have been studying the evolution of human culture, informally, for the last ten years and have developed an interest in the evolution of democratic systems of government. Current government systems are not doing too well at managing obvious problems faced by *Homo sapiens* at present (eg. atmospheric pollution, extreme population and consumption pressures, and resultant competition between humans and the rest of biodiversity for land and ocean ecosystems). These studies have led to the development of a theoretical basis for representative democratic systems that can be applied at any scale from a population of few thousand, to a democratic system at the world scale. This submission applies these theories to the structure of the ACT Government and to addressing the objectives of this inquiry into the size of the ACT Legislative Assembly.

Executive Summary / Recommendations:

1. That the ACT Government plan to increase the number of members of the Legislative Assembly to an eventual number of 35, or greater depending on future growth of the population. This recommendation is based on evidence (see below) that cooperation can deliver more benefits to a society than dependence on competition between individuals, if the society is structured to foster cooperation.
2. That electorates with 7 members each be established in recognition reasonably substantial minority interests (12.5% for a quota) should be represented in the ACT Legislative Assembly.
3. That three 7 member electorates (21 MLA’s) be established in the short term.
4. That four 7 member electorates (28 MLA’s) be established in the medium term, or possibly as the first step if resources allow such a change (Note; I recognise this is outside the current restrictions and possibly the 5 x 5 (25 MLA’s), or the [4 x 5 + 1 x 7] (27 MLA’s) options may be acceptable.
5. That five, 7 member electorates (35 MLA’s) be established over the longer term as financial resources for accommodation and operating expenses, political support for the concept, and recognition of the contribution to the effectiveness of the ACT Assembly learned from experience of the initial step become available or arise.
6. That studies should be initiated into the nature, number and effectiveness of interest groups within electorates that consult with MLA’s. These studies should include assessment of whether the groups, to be effective, should be official, voluntary or both, and to ensure the groups are consistent with the operation of Group Selection Theory.

Introduction:

The structure of the ACT Legislative Assembly needs to evolve in response to changes in the ACT population, changes in demand for its legislative and representative services, and in response to advances in the design of democratic systems of government. This submission recommends changes in the numbers of electorates, and the number of members per electorate, that are achievable in the short term. It also suggests a pathway for the evolution over time of the ACT Legislative Assembly. These suggestions cater for ongoing changes in the population, its geographic distribution, and recognition that major roles of government are to manage the development of cooperation in society, and to control effects of levels of competition for resources that reduce the benefits of the resource to human welfare (eg. the 'tragedy of the commons' experience[5]).

Theoretical Basis:

The recommendations are based on findings from studies of biological evolution, game theory and their degree of correspondence with the actual evolution of Parliaments and Local governments around the world. Evolution and game theory studies have focussed on the conditions under which increased cooperation within groups of individuals using essential resources[1, 2, 3], has been able to dominate and displace groups that sponsor an established balance between competition and cooperation among individuals for resources. In the jargon of game theory, cooperator groups propose increased benefits will be obtained from application of a policy involving increased cooperation and reduced individual competition. Defector groups propose the current policy or some other policy involving less cooperation and more competition should be applied. The evolution and game theory studies have shown the cooperator groups will dominate the defector groups if the benefit to cost ratio of applying the new policy exceeds a critical value (eg. 2; see argument later).

The ACT Legislative Assembly is an example of a representative democratic system with a group of members (the Government) that has the power to legislate to foster, and/or enforce, increased or decreased levels of cooperation between individuals and groups in society (eg. set road and development rules; provide public services and infrastructure; establish laws and law enforcement systems to manage acceptable personal behaviour and business interactions, etc.). In addition the government creates laws under which individuals and groups are free to compete with each other under defined circumstances. Therefore our understanding of the conditions under which cooperation has dominated competition during biological evolution (ie. where the cooperative arrangements have been selected by natural selection as being beneficial to the survival and reproduction of the cooperating individuals of the species), provide sound guidelines for how human societies can manage balances between cooperation and competition when using resources for our benefit. In the broadest sense, a benefit is received from use of a resource if it contributes positively to long-term survival and reproduction of humans within the world and local ecosystems we inhabit. The important inference is that if we design our representative democratic system to reflect systems of control that have been successful over the last 4 billion years of biological evolution, then confidence in the design of the democratic system we develop will be justified.

The most important condition that needs to be met to enable cooperation to dominate competition in a large society, is the Group Selection criteria[1]. Group selection allows the evolution of increased cooperation provided that

$$b/c > [1 + (n/m)] \qquad 1)$$

where:

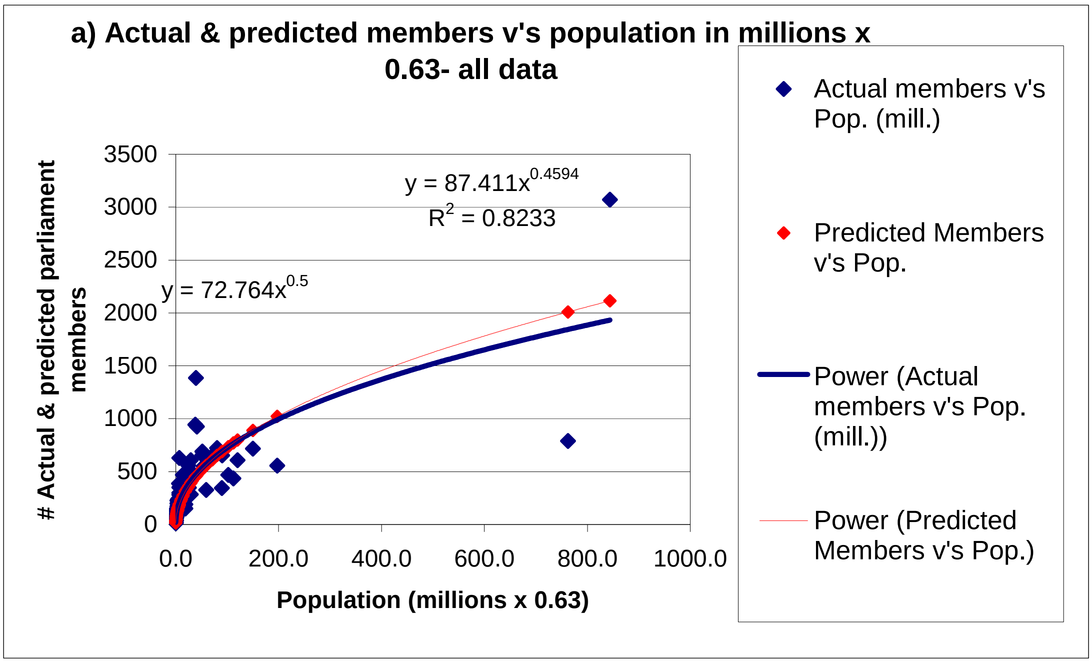
b is the benefit from application of a new cooperative strategy or policy;
c is the cost of applying the strategy or policy (including new costs involved plus the opportunity cost of forgoing benefits from a previous policy or strategy);
n is the maximum group size; and
m is the number of groups in the society.

As outlined in an attached paper[4], it is arguable that where decisions by a parliament need to be supported by greater than 50% of the voting members for the proposal to be accepted, the critical benefit to cost ratio (b/c) for an policy involving increased cooperation needs to exceed 2.0. If this critical b/c ratio is accepted, then calculation of n and m for any population of N voters is possible. For the critical b/c ratio of 2, it can be shown that

$$n = m = \text{square root of } N \qquad 2)$$

Alternatively, other critical b/c values (eg. 1 to 10), could be used and matching m and n values can be calculated for any given voting population.
To this point the Group Selection Theory[1] suggests that cooperation (or a higher level of cooperation) can develop within a society with a voting population of N persons, if the society is divided into m groups of n persons, and the b/c value for application of the new strategy or policy is > the critical b/c value. Projects with higher b/c ratios can achieve cooperation with less groups (m smaller), and more groups (m larger) are needed if the b/c ratio is lower[1].

Is this conclusion supported by the history of the evolution of democratic systems of government? Data from a selection of 66 local, state and national governments was used to plot firstly the number of elected members of the parliaments/councils, plus the members of their executives where the executive was appointed from outside the group of elected parliamentarians (eg. USA and other Presidential systems), against the population of adult voters (assumed to be 63% of the total population - the average for Australia from data in the Discussion Paper) (Fig. 1). Secondly the average number of group selection groups per elected member across all the parliaments/councils was calculated and found to be 13.7 Group Selection Groups per elected member. There was a slight non-significant trend for this number to rise as the voting population increased across the range 0.044 to 940 million. Therefore the number of Group Selection Groups (m) for each voting population was then divided by 13.7 to give a prediction of the number of parliament/council members that would be needed to foster the development of cooperation in society according to the Group Selection Theory. Each member interacts with 13 to 14 sub-groups within their electorate. There was a close correspondence between the empirical regression of the actual number of parliament/council members against the voting population, and the plot of the predicted members against the voting population (Fig. 1).



In other words the group selection theory can be used to predict the number of members of a local, state, national or world government, and suggests that each member should consult with about 13 or 14 groups within their electorate to successfully foster cooperation in the society when the benefit to cost ratio of applying the proposed policy/strategy is greater than 2. *According to the theory these groups are defectors (leave the policy as is or revert to a less cooperative biased policy, eg. typically conservative parties) or cooperators (supporting a supposedly more beneficial cooperative policy, eg. typically progressive parties). The groups may be interest or lobby groups, be official party groups, or be groups that specialise on policies aligned with various government administrative departments. According to the Group Selection Model, groups supporting the established balance between cooperation and competition (the detractors in game theory), will be displaced by groups supporting the new strategy favouring increased cooperation (the cooperators in game theory), if the critical b/c value is exceeded by the new strategy/policy. The implication from the Group Selection Theory is that democratic systems of government that give decision making power to representatives of the population (members of parliament), need to ensure the representatives or parliament members consult with a substantial number of sub-groups within each electorate. Whether these consultations will be more effective if the sub-groups are formal or informal is an open question, the groups are either defectors or cooperators in respect to the acceptance or otherwise of a proposed new strategy.*

Implications for the number of members in the ACT Legislative Assembly:

Table 1: Actual number of members and the number of members predicted by the group selection theory (m/13.7).

Statistic	Tasmania	ACT	Northern Territory	Wagga Wagga City Council
Population	510,000	364,000	229,000	63,000
Voting population (Population x 0.63)	321,300	229,320	144,270	39,690
Predicted number of members	41	35	28	14
Actual number of members & (% of predicted)	40 (97%)	17 (49%)	25 (89%)	11 (79%)
Group Selection Theory group size & number (n & m for critical b/c = 2)	597	505	400	210
Unicameral (UC) or Bicameral (BC) Parliament or Council.	BC	UC	UC	UC

The outstanding feature of the data presented in Table 1) is that the actual number of members, as a percentage of the predicted number of members, for jurisdictions with comparably small populations to the ACT across Australia, is lowest for the ACT at 49%. Other examples studied to date, all exceed 79% of the predicted number of members. Worldwide, among the 66 parliaments included in the study, lower percentages of actual members were only recorded for India (39%) and Peru (48%). Low percentages of actual members were also recorded for Bangladesh (50%), USA (55%), Ecuador (58%), Philippines (59%), Venezuela (61%) and Nigeria (64%). All these are still greater than the percentage for the ACT Legislative Assembly. It is suggested that under-representation in these countries and in the ACT, is likely to be reducing the effectiveness of government in fostering and/or enforcing the application of cooperative strategies and policies that benefit human welfare, and in failing to foster the successful evolution of humans in local, national and world ecosystems.

Lastly, the nature and number of society groups that consult with each parliament member needs to be studied. These studies would indicate whether the democratic system in the ACT complies closely enough to the group selection model, so the evolution of beneficial cooperative policies and strategies can be confidently expected. An alternate way of viewing the current situation in the ACT is that each member of the Legislative Assembly of 17 members, needs to interact with 29 community groups before the representative democracy could be expected to foster establishment of cooperative projects with a b/c ratio > 2.

Recommendations: See executive summary.

References:

1. Nowak, Martin, A. (2006) Five rules for the evolution of cooperation. Science, 314, 1560 – 1563. (Plus supporting material on-line.)
2. Nowak, M. A., Tarnita, C. E., Wilson, E. O. (2010) The Evolution of eusociality. Nature, 466, 1057 – 1062.
3. Nowak, M. A., and Highfield, R. (2011) ‘Super cooperators: Why we need each other to succeed’. Siman and Schuster, USA (Alternatively: ‘Super cooperators. Evolution, altruism and human behaviour’. The text Publishing Company, Melbourne.).
4. Helyar, K. R. (2012) Managing competition and cooperation during human cultural evolution II. Government systems and management of the cultural evolution of *Homo sapiens.* (unpublished manuscript).
5. Hardin, Garrett. (1968) The tragedy of the commons. The population problem has no technical solution; it requires a fundamental extension in morality. Science 162, 1243 – 1248.

Attachment:

Reference 4 is attached as a second document with this submission.

Managing competition and cooperation during human cultural evolution
II. Government systems and management of the cultural evolution of *Homo sapiens.*

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Abstract:

Theories about the conditions necessary for the development of cooperation during biological evolution, are compared in this paper with government systems that have evolved during human cultural evolution. The combined operation of kin selection and group selection theories, assuming the critical benefit to cost ratios for cooperation to develop is the same for each mechanism, is shown to closely correspond to the way governing systems (parliaments or councils) have evolved. The evolution of parliaments and councils has occurred under the influence of natural selection, to govern or establish cooperative arrangements among populations of different sizes. The number of groups needed for cooperation to develop in a population of a given size, can be estimated using group selection theory. On average, there are about seventeen more groups than members in the average parliament or council. An inference is that cooperation may develop most efficiently if each member of the average parliament or council, interacts with about seventeen groups in the electorate that represent the whole electorate population. A second feature of this analysis is that the benefit to cost ratio (b/c) of about 2 must be exceeded before cooperation on a specific project or strategy will be likely to develop in a typical government/opposition type democracy. Supporters typically cluster around two political poles. At one pole are supporters of existing evolutionary stable strategies (ESSs) (typically conservative parties). Clustered at the other pole are groups that support change to new ESSs that address problems that have arisen in the society (typically more radical political parties). The new strategies are claimed to be more beneficial (ie. have b/c ratios greater than 2 when compared with the established ESS). The associated level of cultural relatedness needed to support cooperation in such a system is close to 0.5. The combined Group Selection-Kin Selection theory is then used to estimate an optimal structure for a democratic United Nations government. It can also be used to indicate how current democracies could be changed, to enhance their chances of success in establishing strategies to increase human fitness in their society. The possible roles of direct and indirect reciprocity or altruism, and of network reciprocity, in fostering cooperation between governments at different levels (eg. regional and national levels,) or at the same level (eg. among nations) are outlined.

Introduction:

Questions investigated in the first paper in this series (Helyar, unpublished a) were: Does understanding of the rules and processes that have governed evolution in the past, provide sound guidelines for managing human cultural evolution in future? Secondly, will this understanding help humanity to solve environmental problems that currently threaten human fitness? The most critical resources that require cooperation, rather than unconstrained competition in their development, and that are subject to intense competition rather than cooperation, are land (competition between land for human use or for the rest of biodiversity), oceans (competition between individual fishermen leading to a tragedy of the commons situation), fresh water (competition between users of fresh water for many purposes), and energy (competition between energy suppliers using fossil fuels with other suppliers using non-polluting energy generation systems). After an analysis of the rules and processes that have governed biological evolution, it was concluded that the historic progression of genetic and cultural evolution does provide a useful guide for management of human cultural evolution in the future. The major operational processes involved in the progression of biological evolution (ie. the net effect of cultural and genetic evolution) are: Acquiring new genes or knowledge that increase competitive power for exploiting essential resources; application of the new competitive power to exploit the resource(s); and controlling the intensity of competition for the resource(s) so it does not decrease the net benefit to the fitness of the group using the resource.

It was argued (Helyar, unpublished a) that the two evolutions operate largely independently. Their independence results firstly from genetic evolution being controlled by changes of genes at the organization level of the cell nucleus, while human cultural evolution is controlled by human brains – separated from cell nuclei by several levels of organization (genes on chromosomes, chromosomes in nuclei, nuclei in cells, cells in organs, organs integrated in a body, the brain being the major organ controlling the way the body works). Secondly human cultural evolution is progressing much faster than genetic evolution – so much faster that the effect of cultural evolution on human fitness has left the genetic evolution of *Homo sapiens* standing for the last 40,000 years. The relative contributions of new genes and accumulated knowledge to the development of language, is a good example of the recent dominance of human cultural evolution (Maynard Smith and Szathmary, 1999).

A further conclusion from the analysis in Helyar (unpublished a), was that natural selection selects changes in the gene-environment interaction that increase the fitness of the host species, not just genes. Furthermore this process of natural selection operates in both evolutions. Emphasising the central importance of the gene-environment interaction, highlights the fact that it can be changed by changing genes or the environment. In other words, biological evolution, the result of genetic and cultural evolution operating together (humans being part of biology), involves the effects of cultural evolution on changes to the environment and genes. The environment cannot be considered to be constant, leaving genetic mutations as the only variable contributing to biological evolution. Massive environmental changes do result from cultural evolution. The distinction between natural selection of genes or of the gene-environment interaction is critically important for human cultural evolution because of the large capacity of humans to change their environment to favour their genes.

The theme of this paper is to relate the current status of government systems developed during the historical cultural evolution of human eusocial systems, to evolutionary theories about the conditions needed for the development of cooperation in the competitive environment in which natural selection operates (eusociality is defined as a situation where ‘some individuals reduce their own lifetime reproductive potential to raise the offspring of others’; Nowak *et al*, 2010). Government systems at the world scale (tertiary adaptations of the human environment in the terms of Helyar, unpublished a) appear to be necessary to manage problems at the world scale (eg. agreement on implementation of climate control strategies failed at the UN sponsored multinational conference, Copenhagen, December 2009). Cooperation and eusociality are required at the same spatial scale as the problem. Knowledge of the progress of biological evolution in the past, provides guidelines for development of government systems able to design and apply strategies to deal with excessive competition.

Cooperation is needed to suppress competition for a resource when competition is so intense that the net benefit to human fitness from using the resource(s) decreases. This paper focuses on developing government systems that comply with the conditions required for cooperation to evolve in a population. The next paper (Helyar, unpublished c) deals with how to optimise the mix of competition and cooperation when developing strategies to make primary adaptations to the environment (Helyar, unpublished a) to provide for the basic needs of humans. Secondary adaptations to the human environment, strategies to increase the accumulation and passing on of knowledge and applications of knowledge, are also important components of cultural evolution (Helyar, unpublished a). Strategies to manage secondary adaptations (eg. policies and strategies to foster education, research and invention) are important but not considered in any detail in these papers.

Group and Kin selection theories, and the development of government systems in human cultural evolution:

It is proposed that cooperation between large numbers of individuals can be developed during cultural evolution if at least two of the conditions for the development of cooperation are met (Nowak, 2006). The first condition, known as Kin Selection Theory, is that the benefit (b) to cost (c) ratio (b/c) of a proposed strategy is greater than the inverse of the relatedness (1/r) between two groups in a population of N individuals. This b/c value will be referred to as the critical b/c value. In genetic evolution the relatedness (r) of two individuals is the fraction of the genes shared between the individuals due to their common descent, or more rigorously, r = $(Q-Q_m)/((1-Q_m)$ where Q is the average relatedness of the two individuals and Q_m is the average relatedness of the population (Nowak *et al*, 2010). In human society (assumed to be a monogamous, sexually reproducing society) only small numbers of people can be closely related (eg. r > O.25). However in cultural evolution large numbers of people can be closely related culturally (ie. have a common view about the way the society they inhabit is understood and should be organised –see Helyar, unpublished a). This difference between cultural and genetic evolution, removes a constraint on the effect of kin selection on the adoption of cooperation among large numbers of people, because many people can be closely related culturally (cr replacing r in the kin selection condition).

The second condition that can influence the development of cooperation among large numbers of people is known as Group Selection Theory. This condition is that the b/c ratio of a proposed strategy must exceed the quantity (1 + n/m) where the population (N) is equal to the number of groups in the society (m) multiplied by the average group population (n) (Nowak, 2006). The mechanisms for increased cooperation according to group selection theory are: i) Groups, composed of members that cooperate with each other to increase the average payoff from applying a strategy to exploit a resource, increase their population and eventually split to form two groups. ii) Other groups, with members that compete freely with each other to exploit the resource, fail to gain the potential increase in payoff from cooperation and suffer a decrease in population relative to the cooperating groups. Under an assumption that the total population (N) is constant, the groups with members that compete with each other are eventually eliminated. In a growing population, the groups relying on competition between members may not be eliminated but become a smaller proportion of the total number of groups over time. More detailed explanations of the operation of the Group Selection and Kin Selection processes, are given by Nowak (2006).

The group population (n) and group number (m) for a total population (N) can be calculated for any critical (b/c) ratio if the number of groups is large enough for the assumption that weak selection applies is valid (Nowak, 2006). Estimating the critical b/c ratio is not a problem for the Kin Selection condition because objective means can be used to set cr (eg. polls such as elections to find the proportion of the population that support implementation of a given strategy) from which the critical b/c ratio can be calculated. An attractive approach to estimating n and m is to use the fact that the payoff matrix for kin selection is structurally identical to the payoff matrix for group selection if 1/cr is set to equal (1 + n/m) (see Nowak, 2006; page 7 of ‘Supporting Online Material’). Setting this equality implies an underlying assumption that both cultural relatedness and the group size and group number contribute to the evolution of a beneficial cooperative strategy (check with Nowak). Given that cr can be estimated independently and N = (m x n), then for a population (will change to adult population in future) N:

$$m = N^{0.5}/[1/cr - 1]^{0.5} \qquad 1)$$

and

$$n = N/m \text{ or } n = N^{0.5} \cdot (1/cr - 1)^{0.5} \qquad 2)$$

Substitution of cr into Equations 1 and 2, for any population (N) that is large enough for weak selection to apply (ie. where the group number, m is large enough for the intensity of selection to be much smaller than 1.0), enables estimation of m and n. The critical b/c ratio for both mechanisms for the development of cooperation in a competitive environment, is 1/cr. Henceforth this model is referred to as the combined Kin-Group Selection model, or simply as the KS-GS model.

Equations 1 to 2 can now be used to illustrate how the conditions needed for cooperation to evolve in moderate to large populations (ie. the KS-GS theory), can be used to design government structures likely to be successful in sponsoring cooperation within the society. The guidelines for government structures inferred from evolutionary theory are outlined in Table 1, and in the notes appended to the table.

Table 1: Guidelines for government structures inferred from the linked application of Group Selection and Kin Selection theories (For a total population (N) of 50 million, a range of potential cr values, and an assumption that cr can be set to set equal m/(m + n)).

Cultural Relatedness (cr)	Critical b/c (1/cr & 1+n/m)	Number of groups (m)	Group Population (n)	Implications for government structures
0.1	10	2357	21,213	*** A target 0.1 for cr is easily achieved, but a target of >10 for the b/c ratio for proposed projects is too high for many projects, so this combination is unlikely to be a viable basis for development of democratic government.**
0.5	2	7,071	7,071	**** Targets of 0.5 for cr and 2 for the b/c ratio for proposed cooperative projects could be readily achieved, so are a useful basis for designing democratic government systems able to facilitate the evolution of cooperation in the society.**
0.9	1.111	21,213	2,357	**#Targets of 0.9 for cr and 1.11 for the critical b/c ratio, are not a viable basis for development of cooperation in a democratic government system, because of the difficulty of reaching a cr value of 0.9.**

* A cr of 0.1 is likely to be easily achieved but the high b/c could only be expected in exceptional circumstances.
** A cr of 0.5 is consistent with a 2 party (or two coalition) democratic system. The opposing sides in politics (eg. conservatives v's radicals or progressives) can each achieve a political allegiance near 0.5. Moderate fluctuations either side of 0.5 typically occur as the electorate assesses the benefits being generated by the governing party or coalition. The history of democracies indicates it is usually possible for one group to achieve a political allegiance of 0.5 or more to gain government. The correspondence between the concept of cr and 'political allegiance' is self-evident. The critical b/c ratio of 2.0 also seems to be a practical target for the increase in benefits from operating a new cooperative project, compared with the cost – including the opportunity cost – of the current strategy. Opportunity costs (ie. the net benefit of the current strategy) is a real cost in the estimation of b/c wherever the new strategy is to replace a current strategy. In the terms of evolutionary theory, the two party or two coalition system, is comparable to one side (conservatives) supporting the current Evolutionary Stable Strategy(s) (ESS's), and the other side supporting development of new ESS's designed to address problems caused by high intensities of competition that threaten human fitness (progressives). In this sense the two sides of politics could be described as supporters of new, purportedly more beneficial ESSs v's others who argue the current ESSs are still viable and economically competitive. The

traditional labels of ‘left’ v’s ‘right’, ‘socialists’ v’s ‘capitalists’, ‘radicals/progressives’ v’s ‘conservatives’, approximately fit the ‘new ESS’ v’s ‘established ESS’ concept.
A cr of 0.9 is difficult to achieve in many situations, especially in large and culturally diverse populations. A cr at this level may only be achievable in a society with strong central government and an intensive propaganda program (eg. the church-state systems in Europe in the middle ages; the German society during World War II, and some current societies that insist their population follows a particular ideology, usually mandated by law and law enforcement). Furthermore, estimating the benefits from proposed projects where b/c is close to 1, is subject to estimation errors and the temptation to undertake projects, that once established, turn out to have a b/c ratio less than 1.

Setting the targets for cr and b/c lower than 0.5 and higher than 2, respectively, decreases the number of groups needed but increases the group population (Table 1). This decreases the number of groups that need to be consulted but reduces the number of viable projects that can be undertaken. Alternatively, setting the targets for cr and b/c higher than 0.5 and lower than 2 respectively, increases the number of groups that need to be consulted and increases the number of viable projects, but introduces the problem of tempting governments to change to a new ESS that may be of less benefit to the fitness of the society than an existing ESS because of errors in estimation of the actual b/c ratio for the project (Table 1).

It is concluded that establishment of democratic governments able to gain the benefits to human fitness from cooperation rather than unconstrained competition, is favoured by targeting projects with a b/c ratio greater than 2, and by establishing cultural relatedness within the population (or the proportion of the population in support of the projects proposed by the government) of at least 0.5. Note that for these b/c and cr values Equations 1 and 2 are reduced to the simple expression:

$$n = m = N^{0.5} \qquad 3)$$

The group number and group size increase as the population increases, for all critical b/c and associated cr values. Equation 3 provides a simple basis for estimating the number and size of groups in a society and the degree of cultural relatedness needed for cooperation to evolve in the society through the combined effects of Group Selection and Kin Selection. In the next section the number of members in parliamentary systems that govern their populations is compared with the number of groups predicted by the KS-GS theory (assuming b/c = 2 and cr = 0.5) to be needed before cooperation is likely to evolve.

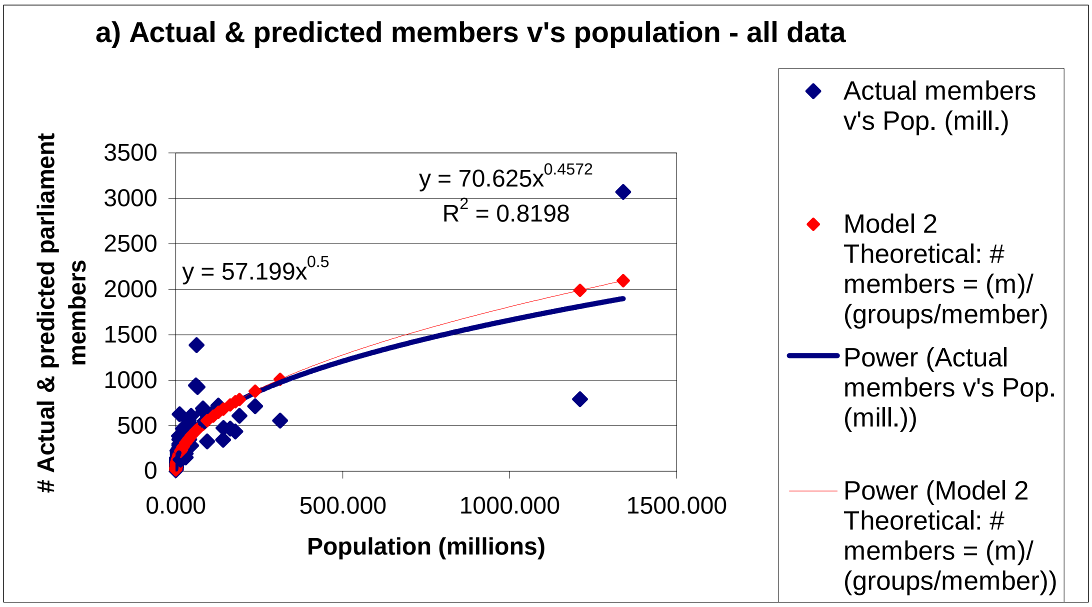
Predicted and actual evolution of government systems:

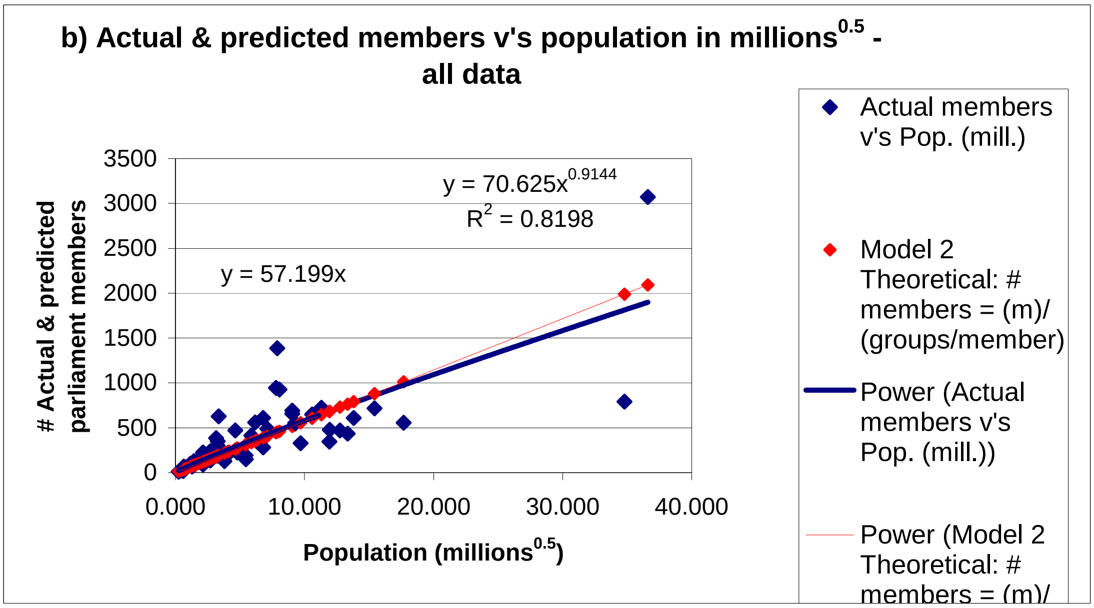
For the 66 parliaments included in this study, the number of groups needed for cooperation to develop with cr set at 0.5 and the critical b/c set at 2.0, was greater than the number of members in the average parliament. The overall average number of groups, per member was 17.5 (denoted by g) (note that this number will change when the adult population (ie. The voting population) is used. If the adult of voting population is estimated to be 70% of the total population then for the 66 parliaments studied the value of g was 14.5), and the range was from 5 (Cuba) to 44 (India). There was a weak linear trend (R^2 = 0.10) for g to decrease as the population decreased. At quite low populations, such as a local government council governing a small population of 10,000, the number of groups is 100 so the weak selection assumption should be valid (Nowak comment?). It seems reasonable to assume the weak linear trend of the value of g with population simply reflects noise in the data on the evolution of parliamentary systems. Therefore the average number of KS-GS Model groups per member of a parliament or council governing a population of N persons, is m/g. The constant g (17.5), applies to all populations and all levels of government, from local to state or region, to national, and to world government. The number (17.5) seemed to be a reasonable number of groups for a single parliament member to consult.

What these groups are and how they interact with the parliamentary members to generate cooperation in policy development and application, is a matter for debate. They may be comparable to the lobby and vested interest groups that typically consult with members of parliament. Whether the development of cooperation would be more successful if the groups were officially established, or encouraged to form and disperse naturally as issues of interest to the population wax and wane, is also a question for debate.

A further observation is that the constant g (17.4) is of the same order as the number of ministerial portfolios in many governments, and to the major changes to the environment humans have made to increase their fitness (Helyar, unpublished a). Typically each Minister oversees a public service department with expertise on an issue of importance to the public (eg. health, transport, housing, defence, etc.). There is a natural correlation between the major changes humans have made to the environment to increase their fitness (Helyar, unpublished a), with the public service departmental structures and ministerial responsibilities historically developed by governments. Ideally the Public Service departments provide assistance to governments trying to manage the changes to benefit, rather than degrade, human fitness. Thus a second possible role for the groups specified by the extended KS-GS Model within each electorate (ie. the combined KS-GS theory plus the coefficient g, used to convert the number of groups needed for cooperation to develop, to the number of groups per member of parliament), is to formally establish about 17 to 18 groups representing a population of about n, in each electorate. Individual groups would have official access to one Government Department and to the local Member of Parliament. Individual voters would be free to join a group that deals with issues they are interested in, and would be free to change groups as their interests change.

Figure 1: (update both figures as new data added and adult population is used) Actual members of parliament (elected members in Westminster parliamentary, unicameral and bicameral, systems, and elected members plus appointed cabinet members in Presidential type parliaments similar to the system in USA) and members predicted by the extended KS-GS model (Group number (m) divided by 17.5, the average number of groups per member across all parliaments included in the study). a) Population in millions; b) Population as square root of millions.





The relationship between the actual or predicted number of members in a parliament as a function of population, is shown in Figure 1. Agreement between the extended KS-GS Model and the equation fitted to the data, is very close under the assumption that the groups/member (g) is 17.4(Fig 1 a and b) . Some of the outliers (actual – predicted members; and the ratio of actual members / theoretical members, in parenthesis) are Cuba (436; 3.26), United Kingdom (935; 3.06), France (464; 2.00), Italy (499; 2.11) and China (977; 1.46) on the positive side, and India (-1199; 0.4), USA (-455; 0.55), Bangladesh (-337; 0.5) and Pakistan (-327; 0.57) are outliers on the negative side. The countries with considerably less members than predicted by the extended KS-GS Model, may need to increase the number of members in their parliaments to increase the probability of development of cooperation in their societies. Alternatively these countries may already have, or need to, facilitate effective communication between parliament members and the relatively large number of groups that each member theoretically needs to consult. The other outliers, with more members than the extended KS-GS Model suggests are needed for cooperation to develop in a competitive environment, have a less onerous consultation task. If, however, the role of the groups is to link ministerial departments to the groups in society (each with a population of about n) and to each parliamentary member, there are not enough groups per member in these countries to link to each department on a 1 to 1 group to department basis, or to groups focussed on each of the classes of changes to the environment humans have made to increase their fitness.

An interesting inference from the data in this section, is that systems of government have already evolved during past cultural evolution, broadly in accordance with KS-GS theory. If the theory provides a valid description of how eusociality can develop in human society, it is not surprising that natural selection during human cultural evolution has selected government systems that are in accord with the theory. The residuals of the regression (divergence from the predicted values) increase as the population increases. Some of the large residuals such as France, United Kingdom and Italy may reflect the derivation of their parliamentary systems from feudal systems that involved lords, nobles or other rich landholders overseeing local populations. Hence the high proportion of upper house members in the older parliamentary systems in United Kingdom, France (proportion members in the upper house 0.53 and 0.62 respectively), compared to more modern parliaments such as Germany, Canada, Australia, Brazil and South Africa (proportion members in the upper house 0.10, 0.25, 0.34, 0.13 and 0.18 respectively). The high total number of parliamentary members in Italy, although not reflected in high numbers in the upper house, may also be related strong pressure for local representation.

Another feature of the residuals is that they increase as the population increases (Fig. 1b). This may be caused by uncertainty about how to manage large populations because there have been only a few governments of large populations have existed during the history of human eusocial development. Natural selection has had little opportunity to select successful models. Consequently the extended KS-GS Model may have a valuable role in extrapolating democratic systems to large populations (eg. the world), and to provide guidelines for democracies that are outliers on the regression to modify their structures.

A potential role in a democratic system of government for each of the groups in the group selection model, has also been indicated. Their role being to link government departments and the major classes of changes humans have made to their environment to increase their fitness (see Helyar, unpublished a), to the 17 to 18 KS-GS groups in each electorate. To my knowledge no existing democratic system has established formal links between existing government institutions, with groups in each electorate that are comparable to the KS-GS groups. Such an arrangement may represent an advance in the evolution of democratic systems of government. It is emphasised however, that the desirability of such a formal role is speculative. Less formal lobby or vested interest groups, that can form and disperse in response to the dynamism of the human environment, may be a more effective means of developing cooperation in our eusocial society. Further discussion of this subject is included in the Appendix.

The cultural evolution of government scales and levels:

In the last section cultural evolution of government systems at different scales (ie. populations) was shown to conform to expectations from the extended KS-GS Model that included the constant g. The number of groups needed in the KS-GS theory to foster the development of cooperation in a society (m) with a given population (N) divided by 17.4 (g), was a good predictor of the average number of parliamentary members. The average number of parliamentary members in a parliament representing a population of N persons, was estimated by regressing the number of parliament members against the populations associated with each parliament. The extended KS-GS theory is useful for identifying parliaments with structures that are not close to the ‘average’ parliamentary structure that has been formed during the cultural evolution of parliamentary systems under natural selection pressure. This is especially true for small parliaments and councils (eg. N is less than 100,000,000 persons) where there have been many opportunities for natural selection to select models that have contributed more to human fitness. The extended KS-GS theory may also be very valuable to extrapolate to governments of larger populations. Because of the scarcity of these governments, and the failure to date to form a democratic government at the world level, natural selection has had little chance to select for success among parliaments that govern high populations.

Within a national population, however, it is common for lower levels of government to have evolved that represent portions of the national, or sub-national population (eg. at a second level - state or regional governments, and at a third level - local government councils). The extended KS-GS theory is applicable to designing these lower level governments because it can be applied to all populations greater than about 10,000. For 10,000 m is 100 so the number of members is 5 to 6 for a g value of 17 to 18. At the extreme of very small family groups or clans with populations of less 1000, m is less than 32 so the extended KS-GS model with g value of 17 to 18 predicts less than 2 members in a government or council. This seems to be too low, indicating that g should be reduced for very low populations. It may also be the case that the assumption that weak selection applies, is violated at these low populations.

The extended KS-GS model does not give any guidance for management of interactions between governments at the different levels. In different democratic systems, however, provisions for managing interactions, and the distribution of political power between levels of government, have evolved. This evolution can be traced through history (eg. the evolution of feudal, king - noble landholder- knight - serf/peasant systems, and democratic, national-state-local government systems). Study of this aspect of cultural evolution is a complex and specialist subject. Its significance as a component of cultural evolution is not in dispute, but to my knowledge it has not been linked to date to evolutionary conditions thought to have governed the development of cooperation.

Cooperation between nations, or states or local councils may develop if the respective governments can be considered equivalent to the individuals specified in the definition of the five rules for the evolution of cooperation (Nowak, 2006). If this applies then for bilateral agreements between governments at the same or different levels:

- The Direct Reciprocity condition may apply (ie. $b/c > 1/w$; where b/c is the b/c for the strategy being considered for agreement; and w is the probability of another encounter between the governments); and/or

- the Indirect Reciprocity condition may apply (ie. $b/c > 1/q$; where b/c is the same as for direct reciprocity, and q is the probability of knowing the reputation of the other government).

Similarly, for multilateral agreements among governments at the same level, or between a government at a higher level negotiating with multiple governments at the next lower level, the Network Reciprocity condition may apply (ie. $b/c > k$; where b/c is as direct and indirect reciprocity, and k, the number of neighbours in the theory, is the number of governments in the negotiation less 1. As the number of states in a nation increases, the network reciprocity condition indicates that it will be increasingly difficult to obtain national agreement to implement strategies because the critical b/c value increases. Agreements between a national government with 1, 2 or 3 state governments ($k = 1$, 2 or 3), rather than with all the states (eg. $k = 5$ to 10), would enable more strategies to be implemented because the b/c value required for cooperation to develop is lower.

The increase in the difficulty achieving cooperation through network reciprocity as k and the critical b/c value increase, could be a useful indicator that a higher scale (level) of government is needed. The higher level of government, established in compliance with the extended KS-GS model to oversee projects with critical b/c values of greater than 2, would be freed from the restrictions inherent in the use of network reciprocity to establish cooperation. Net benefit to the society would result if the benefit from implementation of one or more cooperative strategies exceeded the costs of establishing and operating the higher level of government.

It is concluded that evolutionary theory does provide guidelines for how we can promote the development of cooperation between governments at the same or at different levels of organization. The guidelines and their use historically, are:

- Application of direct reciprocity by establishing bilateral meetings between governments (and/or government departments) at regular intervals, or 'as required', to increase the probability of 'another encounter'. There are numerous examples within nations and internationally of such arrangements.
- In respect of indirect reciprocity, establish a free press and open or transparent government systems with liberal freedom of access to information detailing past and planned government actions. Thus increasing the probability of knowing the reputation of the government, of government institutions and employees, and of individual government members. Campaigns for open and transparent government, and freedom of the press to publish details of government actions and planned actions, are a feature of the environment of government in many countries. There is however a wide range between nations in access to information on government plans and actions. This variability provides opportunities for natural selection to sift systems of government.
- In respect of network reciprocity:
    1. Limit the number of parties to an agreement so it is consistent with the b/c ratio for the strategy being considered (ensure the value of k is not greater than the b/c ratio for the strategy). There are many examples of the development of bilateral and multilateral agreements between governments. Study of their success or failure in fostering

cooperation, is likely to demonstrate the usefulness of network reciprocity.

2. Develop strategies at a higher level of government only where potentially beneficial cooperative strategies cannot be implemented at the lower level of government (eg. current experience indicates cooperative strategies to manage worldwide pollution of the atmosphere cannot be implemented through international negotiations). Attempts to implement a strategy at an unnecessarily high level in the government structure may not deliver increased benefits. Close attention to the costs and benefits of establishing cooperation at different levels of government is required for individual projects, as well as monitoring the effects of the level of government on the critical b/c value required for the evolution of cooperation to occur (eg. effects of the increase in critical b/c with the number of negotiators (k), when relying on network reciprocity to establish cooperative projects).
3. Many different parliamentary systems have evolved. Some are federations of states (eg. USA, Canada, Australia, Germany), or other styles of hierarchies such as the local government/central government system in the United Kingdom, with some regions (eg. Scotland, Northern Ireland, Wales) with semi-independent parliaments, and others (eg. England) with no separate parliament). Upper House – Lower House systems have developed widely so regional interests can be represented in the upper house at the higher level of government. Different electoral systems have evolved for election of members to the lower house (multi-member and single member electorates). Multi-member electorates (eg. the Tasmanian parliamentary system where five State Parliament members are elected by preferential voting in each Federal Parliament electorate in the state) enable election of members representing minority groups as well as members representing majority groups. In contrast members elected in single member electorates usually represent one or other of the dominant groups in the electorate. Non-preferential and preferential voting systems, and various intergrades have evolved in different countries. Further variations include: i) upper house members elected in state wide preferential electorates (eg. the election system for the Australian Senate); ii) systems where the upper house members are appointed by the government currently in power in the lower level parliament (eg. the German Federal system – a system the author is attracted to because of the inbuilt mechanism for supervision of the higher level of government by the lower level). iii) systems featuring a proportion of members of parliament elected by preferential voting in a single electorate for the whole country (a good system for representation of minorities), and the remaining proportion being elected in single member electorates. iv) etc. Therefore natural selection has a lot of variability from which to select parliamentary systems that deliver the increased benefits to the societies that they govern. Paying attention to the conditions that foster the evolution of cooperation (eg. the extended KS-GS model and the constraints on network reciprocity

with increases in the number of ‘neighbours’) is likely to foster the cultural evolution of improved parliamentary systems.

Implications of the extended KS-GS model for displacement of an established ESS by a new ESS:

According to the extended KS-GS model the b/c ratio for a cooperative project to exploit a resource for human benefit, needs to exceed 2 for cooperation to evolve in a society governed by a democratic parliamentary system. For a specific project, however, knowledge of the actual benefits and costs of the project are required to estimate b/c. If b/c is greater than 2 the strategy may develop as a new ESS or displace an existing ESS.

The actual benefits and costs of a given strategy compared to an alternate strategy, and hence the payoff matrix and the b/c ratio, depend on the processes used to gain the benefits, rather than on cr or (1 + n/m). The costs the new strategy (ESS 2) include the cash costs of the new strategy, loss of the net benefits from the established strategy (ESS 1) and any ‘external’ costs recognised by natural selection but that may be ignored in some project designs. Including the external costs is important if their accumulation over time triggers decreases in human fitness (eg. increasing pollution of the atmosphere over time contributing to climate change; loss of ecosystem services such as carbon storage and preservation of biodiversity, by clearing natural vegetation for farming and forestry). Loss of the net benefits from the established strategy is the opportunity cost of changing to the new strategy. Thus the actual costs of ESS 2 are given by:

$$c_{ESS2} = [CC + OC + XC) \qquad 4)$$

where CC is the sum of the cash costs of ESS 2, OC is the opportunity cost or the cost to ESS 2 of loss of the net benefits from ESS 1 (ie. OC = ($b_{ESS1} – c_{ESS1}$) assuming the same cost accounting system has been applied to estimation of c_{ESS1}), and XC is the sum of external costs, or costs avoided by operators of the strategy but that are taken into account during natural selection.

Given the critical b/c value for the extended KS-GS model for operation of the democratic parliamentary system has been set at 2, and the definition of costs in Equation 4), the minimum net benefit (Min nb) of the new strategy (ESS 2) required before it can displace ESS 1 is given by:

$$(\text{Min } nb_{ESS2}) = 2 * c_{ESS2} \qquad 5)$$

The benefits from the new strategy can be estimated using an equation proposed by Frank (2003) to show how different investments in cooperation and competition for a particular resource generate benefits to fitness. The equation includes a ‘group benefit function’ that describes how benefits are affected by different investments in competition and cooperation, and hence provides guidelines for estimation of b and c for a proposed new strategy. Full details of the equation and its application are given in the third paper in this series (Helyar, unpublished c). Once the benefits and costs have been estimated the actual b/c ratio can be checked to see if it meets the requirements for cooperation to evolve and for natural selection of the strategy to be favoured.

Discussion and Conclusions:

The guidelines for developing cooperation have been established (ie. the five rules for the evolution of cooperation – Novak, 2006). Two of the conditions that need to be met for cooperation to evolve among large numbers of individuals, Kin Selection and Group Selection, have been combined in the extended KS-GS model. This model can be used to design the main features of a parliamentary system able to foster cooperation among the population from which it is elected. Only a single coefficient, the number of groups in society per elected member of parliament or council, had to be added to the standard conditions for cooperation to evolve to gain conformity between evolutionary theory and the actual evolution of parliaments. The parliamentary and council systems in the study included wide ranges of spatial organization and populations (local, to state, to nation). The evolution of cooperation is occurring whether or not the rules for the evolution of cooperation have been recognised intellectually. Cooperative arrangements that are beneficial to human fitness may develop more rapidly and potential disasters be avoided in a more timely manner, if the conditions that are needed for cooperation to evolve in the society are deliberately complied with. For any population greater than about 10,000 two simple rules can be applied. The total number of groups in the society is the square root of the population (or possibly the adult population), and the number of groups per member elected to the parliament is about 17 or 18 (or proportionately lower if the adult population is used).

In the current situation there is an urgent need to develop the embryonic world system of government (the United Nations and its agencies). Furthermore there are few government systems at very high populations, only the Unites States of America, China, and India with more than 300 million people. Therefore natural selection has few examples to choose between. Natural selection has been active however, and the break-up of the Soviet Union may be a recent example – time will tell. The contrast between the Indian and Chinese government systems, each with large residuals in the regression of the number of members of parliament against the population (Fig.1 a and b) and with fundamentally different systems of government, does provide opportunities for natural selection pressure to operate. Thus the task of increasing the scale of government from governing 1 billion to 7 billion people at the world scale is very demanding, but the agreement between the extended KS-GS theory and the average size of actual parliaments for a given population (ie. the regression line), is encouraging. Humanity is faced with the task of developing a cooperative means of managing the current problems that are threatening to decrease human fitness. This urgency means it is important to use of all we know, about how to develop successful cooperative systems of government for large populations, and of how to design strategies able to overcome the problems (see Appendix for a suggested world parliament that conforms with the extended KS-GS model). The need for a form of democratic government at the world scale is now evident. The scale of the threats to human fitness that now exist, have created this need.

Use of the KS-GS model to help design democratic systems of government that will comply with the requirements for cooperation to evolve during human cultural evolution has led to two interesting suggestions. Firstly, that a critical b/c ratio of 2 is a practical target to aim for when designing new strategies to solve significant problems that threaten human fitness or to increase the benefits from using a given resource to increase human fitness. Secondly, in opposition/government type democracies parliamentarians tend to cluster around two philosophical poles – conservatives in favour of supporting current policies or strategies, and a more radical group that supports changes to existing policies and strategies. These philosophical poles are closely correlated with support for established ESS's v's support for new and more beneficial ESS's. The KS-GS model indicates supporters of the established ESS need to demonstrate that the new ESS has not met the required b/c ratio of 2, and vice-versa for the supporters of a new ESS.

The objective of any new strategy is to increase the contribution of the human gene - human environment interaction, to human fitness (ie. to increase the b/c ratio for new strategies compared to the current strategies, so the critical b/c needed to enable cooperative development of the new strategy to evolve is exceeded). Policies aimed at generating benefits need to take into account the way total benefits vary with different investments in cooperation and competition, and estimates of costs must include cash costs, costs that are sometimes ignored but by natural selection (externalities), and the opportunity cost of losing the benefits of a current strategy. Designing and applying improved cooperative strategies to exploit resources for human benefit and to solve problems created at the world scale by maladapted strategies currently being used, is the task *Homo sapiens* needs to solve. The next paper in this series (Helyar, unpublished c) deals with the application of evolutionary theory to designing strategies for exploitation of essential resources for human benefit that will increase, rather than decrease, human fitness (ie. generate increased net benefits and exceed critical b/c ratios).

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Acknowledgments:

Appendix 1: A suggested World Parliament based on evolutionary theories about the conditions for cooperation to develop, and on the historic evolution of parliamentary systems Summary in Appendix Table 1.

The concept of world government can generate fear of the development of a world level tyranny. However problems that threaten human fitness have developed at the world scale. Examples are: A ‘tragedy of the commons’ in ocean fisheries; pollution of the atmosphere with greenhouse gasses leading to climate change and sea level rise; competition for land for supply of food, fibre, and timber for humans, with land for preservation of biodiversity, for carbon storage, for clean water supplies, for recreation, etc.; and the ongoing risk of nuclear war and international conflicts in general. Other problems could be added to this list, such as world trading regulations, population growth, management of fresh water and food supplies, control of international finance and global corporations, and a more effective international justice and law enforcement system. It is clear that there is a pressing need for an authoritative and accepted government at the world scale to deal with serious threats to human fitness. A concept of a world government that is based on our knowledge of the conditions that have enabled the ascendency of cooperation over competition during biological evolution, is presented below. Such a government could evolve from the current United Nations organization, which is essentially undemocratic, represents nations rather than voters under the democratic principle of ‘one person, one vote’, and is dominated by the militarily strongest nations rather than the people being governed. This type of structure is comparable to government structures that preceded the development of democracies within nations. National governments evolved out of that state, so why not the world government? The following proposal for the structure of a world government, are derived from theories of how cooperation has developed in the competitive environment of selection of the fittest during biological evolution (cultural plus genetic evolution), and from evidence of the way governments have evolved historically during cultural evolution. The suggested structure has been developed largely without the benefit of formal studies of, or training in, government or politics. As such it can only be regarded as a starting point, and needs exposure to experts in the field of government for further development. Some objectives are to highlight the contribution evolutionary theory can make, to emphasise the urgency of the problem, and to stimulate a process of rapidly evolving the United Nations toward a more democratic and effective organization.

The extended KS-GS model can be used to calculate the number of groups in society, and their populations, that need to exist for cooperation to develop when cultural relatedness is 0.5 and the critical b/c value is 2. The reasons for choosing the value of these variables have been discussed in the paper. It is also emphasised that the theory and the empirical regression of data from actual parliaments (ie. parliaments that reflect the historic cultural evolution of governments) agree very closely with each other (Fig. 1).

Under the above assumptions of values for cr and critical b/c, the number of groups (m) needed for cooperation to develop, and the population of each group (n) is equal to the square root of the total population (N). For the current world population of about 7 billion, m and n are 83,666. The average value of g was 17.5 (the average number of groups per parliamentary member, for a selected group of 65 parliaments and local government councils across the population range from 63,000 to 1.340 billion). Therefore the number members in the proposed government, is 4781.

A bicameral world parliament is suggested, with the structure of each house being similar to the German federal-state system. This arrangement enables the legislation proposed by the lower house, composed of elected members of the world parliament, to be supervised by the upper house whose members are appointed by the governments in power at the national level (see discussion of network reciprocity in the section ‘The ongoing cultural evolution of government scales and levels’ above.). In theory this principle could also be applied to interactions between governments across other levels within nations (eg. local government-state government, and state government-national government interactions). The Prime Minister/President and the cabinet, would be elected or appointed from members of the lower house, and most legislation would be initiated in the lower house, as in the German and Australian federal systems.

Among the selected group of parliaments in this study, 38 were bicameral.
The average proportion of members in the upper houses was 0.28. An arbitrary choice for the world parliament is that two thirds of the total members (3187) would be elected as members of the lower house to represent populations of 2,196,423 (number groups/total number of members x group population x 3/2). As discussed in the paper it is desirable to elect representatives of the lower house by preferential voting from electorates with five members to ensure significant minorities (about 20 % of the population) can gain representation in the parliament. Under this condition electorates would have populations of 10,981,165. Nations with population smaller than this would have less than 5 elected members, so would have less chance of electing members from minority groups. The extreme situation is nations with populations less than 2,196,423 that would qualify for only one member, or a fraction of a member. In such cases it may be possible for small nations to share members or to rotate their right to representation through time.

The role of the 17.5 groups specified in the extended KS-GS model that are allocated to each member of the parliament, needs discussion. The following are the authors' thoughts on the matter, and there may be many other equally valid schemes, such as less formal lobby groups that represent specific interests of sections of society. In the text it was suggested that individual groups could be 'interest groups' focussed on the area of responsibility of an individual Minister in the government, an the public service department the minister supervised. This was based on the empirical observation that the number 17, is of the same order as the number of Ministers in many parliaments. Seventeen is also close to the number of primary, secondary and tertiary changes humans have made to their environment to increase the contribution of the gene-environment interaction to their fitness (Helyar, unpublished a). So this role for groups can be directly linked to the way governments operate and have evolved to date. The interest groups would have official access to the expertise of the public service department, and to the member they were associated with. Membership of the interest groups would be voluntary and could reflect the interests of individuals and how those interests may change through time. In terms of the continuing evolution of democratic systems such a group structure would provide the means for individuals to have official input into strategy development and application, rather than having to rely on one-to-one contact with their local member of parliament. In addition it would provide individual parliamentary members with advice from the electorate community on a wide range of strategies the government is dealing with – a 'grass roots connection' within the democratic system.

Elections could be held each three or four years, with governments elected for fixed terms. Many other subtleties, such as effects of no-confidence motions, circumstances that precipitate an election or a change in the government within the term of a parliament, the powers and role of the chairperson/speaker of the house, how to change the number of members and electorate boundaries as the population changes (could be almost automatic if the extended KS-GS theory is used), etc., need to be specified in a constitution.

Table 1: Details of a suggested world parliament, based on evolutionary theories about the conditions governing the development of cooperation in the competitive environment of natural selection, and evidence of the cultural evolution of existing parliaments.

Parliament feature or population statistic.	Population or other statistic	Basis for the statistic	Comments
World population (N)	7 billion	Census data	
Number of groups in society needed for cooperation to develop (m).	83,666	Combined Kin Selection-Group Selection theory.	Assuming cultural relatedness is about 0.5 and the critical b/c for cooperation to develop is 2.
Group population	83,666		
Total number parliament members.	4,781	Extended Group Selection-Kin Selection theory. The extension being the conversion factor, the	g = 17.5 groups per member, where g is the average number of groups per member in a

		number of groups per member.	selected set of 66 parliaments.
Number of Lower House (LH) members	3,187	An average proportion based on the cultural evolution of existing modern parliaments.	Many modern parliaments have about two thirds of their members in the LH.
Population per LH member	2,196,423	Calculation from other items.	
Population/ 5 member electorate.	10,981,165	Calculation from other items.	LH members elected in 5 member electorates to enable minority groups in the electorate to become members (cf.Tasmania).
Number of Upper House (UH) members.	1,594	An average proportion based on the cultural evolution of existing modern parliaments.	Many modern parliaments have about one thirds of their members in the UH. Some older parliaments, evolved from previous feudal systems have higher proportions of the total members in the UH.
Population / UH member	4,391,468	UH members appointed in proportion to the national population by National Governments.	Appointed by the lower level government to enable national governments to supervise legislation developed in the LH at world level (cf. German federal system).

- Many other features of the government system such as the specific powers of the LH and UH, parliamentary and election procedures and rules, and the powers of the world parliament relative to national parliaments (ie. the way sovereignty is partitioned between nations and the world parliament, need to be developed in a constitution).

Appendix 2: Reforming the Legislative Assembly in the Australian Capital Territory.

Possible inclusion here of a re-design of the Legislative Assembly in the Australian Capital Territory, that has only 17 members to represent a population of 364,000. This number falls far short of the recommendation by the extended KS-GS model that there be 35 members.