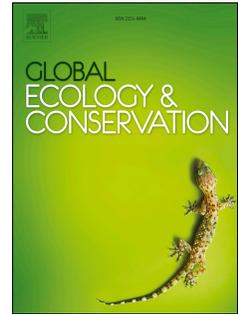


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A SCIENTIST'S WARNING TO HUMANITY ON HUMAN POPULATION GROWTH

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A SCIENTIST'S WARNING TO HUMANITY ON HUMAN POPULATION GROWTH

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19 **ABSTRACT**

20 One needs only to peruse the daily news to be aware that humanity is on a
21 dangerous and challenging trajectory. This essay explores the prospect of adopting
22 a science-based framework for confronting these potentially adverse prospects. It
23 explores a perspective based on relevant ecological and behavioral science. The
24 objective is to involve concerned citizens of the world in this enterprise. The
25 overall objective is to maintain Planet Earth as a favorable home for the future of
26 humanity. Nine ecological principles explain one major aspect of what is
27 happening and provide critical guidelines for appropriate action. Nine social
28 behaviors explore how we might integrate social science insights with those from
29 ecology. Twenty predictions are proposed based on these ecological and social
30 science principles plus existing trends. If these trends are not vigorously and
31 courageously confronted, we will likely be on track for the demise of our
32 civilization. As we examine these challenges, our job will be especially complicated
33 because a major segment of humanity is not prepared to accept evidence based
34 on science, and this generates much resistance to any efforts directed toward
35 effective control of current and future challenges. In these complex
36 circumstances, we must remain as cooperative and optimistic as possible so that
37 we can promote the needed willpower and ingenuity.

38 This essay has broad support as it is a contribution to the Scientists' Warning to
39 Humanity Program of the Alliance of World Scientists (Ripple et al. 2017).

40 **KEY WORDS:** authoritarianism, cooperation, democracy, , morality, population
41 dynamics, social behavior

42 **I. INTRODUCTION**

43 Planet Earth is an absolutely amazing place. An apparent rarity in the universe,
44 it possesses the appropriate physical conditions to support life. As a result it hosts
45 a tremendous variety of living creatures which we recognize and classify as
46 various species. In relatively recent times, human life evolved, and in large part
47 due to our extraordinary intelligence, has

48 become the dominant life form on the planet. With nuclear power technologies,
49 we are now capable of destroying all complex life forms, including ourselves. Our
50 dominance is recognized by the acceptance of the term Anthropocene which
51 proclaims that we have entered a human dominated planetary phase. Our
52 numbers are projected to increase from an estimated 7.6 billion to 10 billion by
53 2050 (Baillie and Zhang 2018). Human caused species extinctions have also
54 reached an unprecedented rate such that we are generally viewed as causing the
55 sixth mass extinction episode for the planet. A recent effort to photograph
56 human impacts on land use over the entire globe from 1992 to 2015 documents
57 this rapidly increasing global-scale impact on land areas (Nowosad , Stapinski, et
58 al. 2018). The inevitable questions for humanity at this stage in our history are:
59 “Does this matter for our species?” “Does this rapid increase in numbers along
60 with its corresponding expansion of our utilization of the Earth's land area
61 matter?” “What does it mean for us?” Maybe it is merely a signal that we are a
62 very successful species, and we can celebrate our good fortune. On the other
63 hand, perhaps it is a signal that we are over-exploiting the Earth's resources and
64 we should seriously be preparing for a population crash. Or, are there still other
65 scenarios? In the following two sections of this essay, we will explore these
66 questions from the perspective of ecological science and then again from
67 behavioral science. Subsequently, we will look for lessons learned by considering
68 20 predictions that emerge from our analysis.

69 **2. RELEVANT ECOLOGICAL PRINCIPLES**

70 Nine established principles of ecological science that are relevant to the
71 circumstances we face are as follows:

- 72 1. Population growth in numbers on a finite planet cannot continue
73 indefinitely for any living species, including humans (Czech 2013, Meadows
74 et al. 2004).
- 75 2. Population growth generates three possible negative forces that collectively
76 increase exponentially and eventually stop growth. These are increasing
77 mortality rates, decreasing birth rates, and increasing rates of emigration
78 relative to immigration. Only the first two of these are applicable with a
79 global perspective. Separately or collectively, these negative processes
80 cause population growth to stop. If access to required resources has been

81 compromised during growth, the population may not only stop growing but
82 decline or even crash (Lidicker 2002).

83 3. Living systems require energy for their ongoing existence. The proportion of
84 available energy that is required for maintenance of living systems increases
85 as the size and complexity of those systems increase. This means that the
86 proportion of energy available for other desirable activities such as
87 reproduction, individual growth, maintenance of health, and defense
88 against parasites and pathogens will be proportionally and progressively
89 less and less available as numbers increase (Brown, J.H., Burnside, R. et al.
90 2011).

91 4. For social species such as humans, increasing numbers require additional
92 energy for maintaining the integrity and cohesion of the groups to which
93 they belong, and on which they depend for their livelihood.

94 5. The resources that humans need to support their food and shelter
95 requirements are partly non-renewable and partly renewable. The first
96 requires the extraction of various minerals, water, fuels, and building
97 materials. Over time these resources will decline and become increasingly
98 more difficult to extract. In the case of fresh water, supplies are becoming
99 increasingly polluted. This not only affects us directly, but also all of the
100 non-marine species that constitute the basis for our food supplies,
101 medicinal drugs, other building materials, as well as a myriad of so-called
102 “ecosystem services”. This trend also can influence weather patterns.
103 ..Recent studies have concluded that our annual supply of renewables is
104 now being used up by about August 1 of any given calendar year. Thus for
105 five months we are deficit spending these resources, and in the process
106 generally doing damage such that the Earth’s capability of generating these
107 renewables becomes diminished (Wakernagal, et al. 2002). This human
108 impact on the generation of these essential resources has been dubbed
109 “the human footprint.” Two diverse examples illustrate the major impacts
110 that humanity is making on renewable resources: 1) Mongolian steppe
111 grasslands are heavily degraded because of exploding demands for
112 cashmere wool plus a series of unusually severe winters (MacLaughlin
113 2019); 2) Diadromous fish populations in the north Atlantic have declined
114 dramatically from multiple causes (Limburg and Walden 2009).

- 115 6. The human enterprise cannot succeed by going it alone (Crist et al. 2017,
116 Heal 2017). Success requires the presence of a rich biota to provide the
117 conditions necessary for our survival. As mentioned, these enabling services
118 have been labeled with the metaphor of “ecosystem services” (Daily 1997,
119 Norgaard 2010). This concept has been reasonably successful in calling
120 attention to our dependence on the Earth’s biota for humanity’s existence
121 and welfare. These benefits that non-human organisms provide for us
122 include oxygen generation, soil fertility, pollination of crops and other plant
123 food resources, fisheries, air and water purification, pest control, medicines,
124 genetic resources, fuel, building materials, weather moderation, dispersal of
125 seeds and nutrients, partial stabilization of climate, mitigation of floods and
126 droughts, decomposition of wastes, industrial applications, etc. And, this is
127 not to mention the provision of a healthy, aesthetic, and intellectually
128 stimulating environment (Daily1997).
- 129 7. Confounding the Earth’s declining ability to supply a steadily accelerating
130 supply of the resources upon which we depend is that the species of living
131 organisms that are required for production of renewable resources are
132 increasingly facing population declines and risks of extinction because of
133 ongoing fragmentation and degradation of the natural habitats that they
134 need for maintaining healthy populations with long term viability
135 (Ascensão, et al. 2018, Tucker,M.A.,K. Bohnning-Gaese et al. 2018, Hilty, et
136 al. 2019, Laurance 2019).
- 137
- 138 8. Fortunately, it is the case that when populations and communities of
139 numerous species are damaged by human activities or unusual forces, they
140 can quite often recover over time if they are suitably protected from
141 subsequent damages. However, we now know that if a community is badly
142 damaged, it can experience a “tipping pint” or threshold such that it cannot
143 recover (Dai et al. 2012, Roque, et al. 2018), and It then becomes a different
144 kind of community that is generally less productive, and much less useful to
145 humans. This illustrates one of the many mechanisms that result in reduced
146 resource availabilities, or expanded human footprints, as populations
147 continue to build.

148

149 9. As we strive to preserve as much of our natural heritage as possible, we
150 need to be aware of an often neglected feature of highly motile species.
151 This is that individuals of such species often need more than one kind of
152 suitable habitat. For example, there may be different habitat types required
153 for different life history stages. An obvious example is species of frogs that
154 begin life in a freshwater pond, but then metamorphose into adults that live
155 in a forest. Many species are seasonally migratory, utilizing quite different
156 habitats at different seasons. Some may even require particular transit
157 habitats. An interesting case is that of caribou (*Rangifer tarandus*) in
158 eastern Canada. Individuals that spend the winter at greater distances from
159 their summer range survive better, but as a result such individuals will
160 require larger home ranges (Lafontain, et al. 2007). A particular hazard for
161 some migratory species is that the travel routes may need to be learned
162 from conspecifics (Festa-Bianchet 2018, Jesmer, et al. 2018). This implies
163 that if social groups get too small they may lose all their potential leaders,
164 and hence access to migratory destinations.

165 I III. RELEVANT SOCIAL BEHAVIORS

166 The following nine social behaviors can and should be recruited to help
167 humanity respond to the ecological impacts that will surely endanger human
168 civilization if current trends are allowed to continue.

169 1. We must explicitly recognize the need for an appropriate mixture of altruistic
170 and self-promoting social behaviors. The first of these benefit the
171 sociopolitical groups to which we belong (the common good), and the second
172 group of behaviors supports the individual welfare of each of the citizens that
173 constitute those groups (Reich 2019). Both are essential for our ongoing
174 welfare. This principal emphasizes the necessity of having democratic
175 mechanisms in place that promote true feelings of participation in the
176 crafting of sustainable societies. This spirit of cooperation is essential for
177 encouraging discussions that generate an appropriate mixture of benefits to
178 individuals and to the success of the sociopolitical groups to which they
179 belong (Reich 2019). Moreover, there will need to be a system of appropriate
180 sanctions for individuals who have overly selfish or parasitic tendencies. This
181 dual-purpose social behavior has a long history going back to our primate
182 ancestors (de Waal 2015) and is clearly expressed in the U.S. Constitution. An
183 illustrative example of how far we have drifted from this principle is provided

184 by a quote from David Starr Jordan, a famous fish biologist who was a
185 Professor of Zoology and later President of Stanford University, that is
186 preserved in a 1933 8th grade graduation diploma from a school in Hawaii.
187 Jordan's message includes the statement that "Success means service. The
188 more you serve the cause of others, the greater will be your own success." In
189 modern societies, this duality of behavioral modes is rarely explicit and
190 increasingly favors individual benefits. When it is discussed, it is often put in
191 terms of pursuit of private wealth (money) versus self-sacrificing altruism.
192 Another unfortunate expression of this duality that has become common in
193 the political dialog in the USA often occurs when behaviors that support the
194 common good are labeled as "socialism." While technically correct, this term
195 translates for many Americans into "communism" which has widespread
196 negative connotations. On the other hand, the single minded pursuit of
197 money is justified as beneficial capitalism. These unfortunate interpretations
198 of "socialism" make it more difficult to promote democracy which
199 unequivocally requires a balance of the two modes of social behavior
200 (Lidicker 2003, Reich 2019).

201 2. Sociopolitical groups are hierarchically arranged, and all individuals must be
202 contributing members of one or more groups, preferably including groups at
203 multiple hierarchical levels. For example, an individual may belong to a
204 neighborhood group, a county government, and a professional vocational
205 association. National citizenship is an almost ubiquitous example of group
206 membership.

207 3. Dialogue at all levels needs to be respectful of the huge array of world views
208 that currently exist in and among various social groups (Reich 2019). When
209 serious disagreements arise within a group, it is often appropriate and
210 effective to promote conversations with the observation that differing
211 viewpoints generally will accommodate many objectives or components that
212 are held in common. Hopefully, encouraging this approach will make it
213 possible to address disagreements in a cooperative and compromising
214 manner. An example of such a cultural impediment that needs to be
215 confronted is the almost universal prohibition against including human
216 population growth in relevant discussions (Bongaarts, O' Neill, et al. 2018).

217 4. Appropriately there are often moral issues that need to be discussed or at
218 least acknowledged in any considerations of human population growth.

- 219 Moral principles are mostly acquired in childhood and as youthful adults. As
220 such they are very difficult to modify. Our deliberations need to respect that
221 reality. Tampering with human population growth is a topic that is loaded
222 with moral issues. Those that accept the relevant scientific evidence are often
223 accused of being genocidal, racist, anti-poor folks, anti-religion, and generally
224 anti-human. These accusations are completely in error. In fact, the position
225 taken in by the scientifically aware is the opposite. Generally, those who
226 accept the scientific imperative feel that they have a moral responsibility to
227 be concerned about the future of mankind. Usually they also are genuinely
228 concerned about the huge inequities in the distribution of resources around
229 the Earth. For many there is also a moral concern for the drift of governments
230 away from democracies and into authoritarian regimes. This trend
231 encourages increasing xenophobia which in turn generates a lack of
232 cooperation among groups, and inevitably increasing negative interactions.
- 233 5. When engaging in discussion topics that deal with conservation and the future
234 of humanity, it is generally advisable to avoid arguments based largely on
235 aesthetics, love of nature, and related approaches. While these positions are
236 valid in the context of particular world views, they are all susceptible to being
237 characterized as the products of special interest groups, and tend to be
238 divisive. Teachers and leaders at all levels need to appreciate that opinions
239 which humans grow up with are very difficult to change by reasoning and
240 argument alone. The multiple viewpoints can be accommodated by
241 compromises, cooperation, and mutually supported programs and policies.
- 242 6. Community discussions are much more likely to succeed if the participants
243 have sufficient education so that they can differentiate truth from falsehoods,
244 and know how to think critically. This means that successful societies must
245 provide good public education that is readily available to all children (Lidicker
246 2003. Reich 2019).
- 247 7. Related to this last array of social behaviors is the extremely important and
248 yet very difficult social issue of the appropriateness of humans deliberately
249 manipulating their own species numbers. One world view on this is that
250 humans should do what they can to have as many members of their own
251 species living on our planet as they can. This view was ingrained in our genes
252 for almost all of human history, and surely has contributed to our successful
253 survival and expansive distribution. It is also ingrained in many of our cultural

254 behaviors and beliefs. A logical corollary of this viewpoint is that any effort to
255 control population growth is genocide and inherently racist. However, in recent
256 decades other issues relating to population growth have emerged. For
257 example, it is now widely believed that women should be able to determine
258 when and for how many times they should become pregnant. Known
259 outcomes of this view are: smaller families that are less likely to live in poverty,
260 improved education and hence job opportunities, communities with higher
261 average standards of living, less criminal activity, healthier citizens, democratic
262 governing structures, etc. Moreover, it is increasingly apparent that without
263 constraints on population growth there is also the inevitability of genocide of a
264 different type (see ecological principles 1-3) along with the following 20
265 realistic predictions. Peacefully debating the virtues of these two modes of so-
266 called genocide will be a monumental challenge, but one we must face
267 (Kopnina and H. Washington 2016, Kopnina and B. Taylor et al. 2018,
268 Washington, Lowe and Kopina 2019). The good news is that there is abundant
269 worldwide evidence that if adults have the tools and understanding needed for
270 controlling their own reproductive output, it will be modest and sustainable.

271 8. An aura of optimism is important. Pessimism leads only to inaction followed
272 by failures and more pessimism (Lidicker 2011). An encouraging hopeful sign is
273 the recent widespread mobilization of youthful activists in support of
274 numerous progressive causes.

275 9. Conservationists should more aggressively confront the social tendency to
276 minimize or ignore long term consequences of development projects, and
277 take advantage of opportunities to educate the public about the issues
278 involved (Laurance et al. 2014). Litigation also can be a tool for delaying
279 projects long enough for public education to become effective (Florens and
280 Vincenot. 2018).

281 **IV. REALISTIC PROSPECTS AND PROBLEMS**

282 Obviously we need to muster all our resources and social skills to prevent
283 continuing in our currently unsustainable trajectory. Equipped now with an
284 ecological and behavioral framework, we can begin to carefully construct
285 guidelines to inform our future efforts. A reasonable place to begin would seem to
286 be an outline of our goals for humanity in the immediate future. Do we accept a
287 fate of massive poverty, massive mortality from wars, terrorism, and disease, and

288 uncontrollable migrations to the places where basic resources are still available?
289 This is our current trajectory (Brown 2006, Heal 2017, Kopnina and Washington
290 (2016), Stokstad 2019). We can assume, I hope, that we would prefer a future that
291 features a comfortable standard of living with minimal disparity among individuals
292 and social groups, high levels of education, and democratic organizational
293 structures for social groups at all levels of organization. In this way, everyone can
294 feel they have input into decisions being made that likely will affect them.
295 Especially important is respectful coexistence of diverse cultures and world views.

296 In the recent past, there has been much discussion as to whether our
297 deteriorating situation should be blamed mainly on human population growth or
298 whether affluence and pollution should share as major contributors (Ehrlich and
299 Holdren 1971). Actually, these three factors interact in complex ways. For example,
300 while improving the standard of living of people everywhere is clearly a desired
301 objective, this certainly would add to the consumption of renewable and non-
302 renewable resources. On the other hand, if affluence were more equally
303 distributed than it currently is, it would improve the situation so that people in
304 general are more content with their lives and hence are more likely to be
305 cooperative and productive. Pollution of our environment also reduces our
306 standard of living through its negative impacts on our health, and by increasingly
307 deleterious impacts on our agriculture, parks, and natural areas. This in turn
308 reduces the health benefits of natural areas (Weinstein, et al, 2015), and
309 diminishes the rate of replenishment of renewable resources.

310 An often heard argument is that technological advances will allow us to
311 overcome the negative effects of population growth. Technology can and certainly
312 will contribute to a slowing of the current negative trends. However, at this time in
313 our history it is apparent that rapid human population growth along with out-of-
314 control climate change will not only quickly cancel out many of the benefits for
315 humans that technology may contribute, but it will continuously add new
316 challenges as population growth, resource depletion, and climate change
317 continue. Mann (2018) engagingly discusses this dichotomy of prevailing
318 beneficial natural processes dominating our future versus a technology based
319 "green revolution." Probably some combination of these two survival strategies
320 will prevail. The reality, however, is much more complicated. Superimposed on
321 these two approaches, we face the real possibility that current and future climate
322 changes will force humanity worldwide to confront widespread disruption of

323 human communities and ecosystem services, not to mention negative impacts on
324 biodiversity (Norgaard 2010, Nolan et al. 2018). For example, we can anticipate
325 warming climates increasing crop losses to insect pests, especially at temperate
326 latitudes (Deutsch et al. 2018). Moreover, it is especially important that we plan
327 for anticipated extreme weather events and catastrophic fires. An example of a
328 positive recent research finding is that restoring large grazers to depleted range
329 lands can blunt the impacts of major fires in those situations (Pennisi 2018).

330 Hopefully, the negative projections might increase the awareness of the public
331 and governments regarding the necessity to confront the drivers of climate
332 change more vigorously. Inevitably, this will incorporate an increasing focus on
333 slowing of human population growth. Unfortunately, many humans, probably
334 more than half, are opposed to any plan that would involve slowing and
335 eventually stopping human population growth. There are many reasons for this
336 point of view that makes folks unwilling to confront the risks we collectively face.
337 One important reason for this reluctance is that since the late 1970's, most world
338 cultures have moved toward rewarding individual benefits over supporting the
339 common good. This trend compromises the feeling of cooperation within the
340 social groups to which we all belong and depend on for our survival (Reich 2019).
341 More troublesome is the realization that, as mentioned, many folks view any
342 efforts to contain population growth as homicide, etc. In reality, efforts to control
343 our runaway population growth are precisely and explicitly the opposite. We
344 want to improve the welfare of people everywhere, and strive to eliminate
345 poverty, racism and other forms of xenophobia. Lastly, we would want to maintain
346 an individual's freedom to control their own reproductive activities. The only
347 constraint on an individual's behavior is that it must be compatible with the needs
348 of the social groups to which they belong.

349 **V. REALISTIC PREDICTIONS**

350 Realistic predictions can be derived from ecological and sociopolitical
351 knowledge as well as from already existing trends, and can serve to motivate
352 appropriate actions. An example of a well-established existing trend is that of
353 global warming. Scientists have been concerned about this human caused
354 trend at least as far back as 1966 (Landsberg 1970). Predictions, however, are
355 inherently risky, especially given the power of human ingenuity to address
356 perceived problems. Three examples of failures to predict accurately are: 1) the
357 much faster than predicted sea level rises associated with the deltas of large

358 river systems (Voosen 2019); 2) The unanticipated huge wave of unusually hot
359 water that beginning five years ago swept across the Pacific Ocean causing
360 widespread havoc with fisheries, seabird populations and whales, and is
361 currently developing again (Cornwall 2019); and 3) Concentrations of the
362 greenhouse gas methane are increasing in the atmosphere more rapidly than
363 predicted (Mikaloff, Fletcher, and Schaefer 2019). In general, modern chaos
364 theory supports the generalization that when dealing with complex systems,
365 longer term predictions are more reliable because they are guided
366 predominately by deterministic processes, while shorter term predictions are
367 less reliably accurate since they often are strongly influenced by random
368 processes. In general it will be very difficult to predict the ability of species and
369 the communities of which they are a part to adapt successfully to the rapidly
370 changing conditions in our future (Bridle and van Rensburg (2018). In this
371 cautious spirit, the following 20 predictions are offered as potential warnings.

- 372 a) The Earth's per capita ability to supply basic food resources for humans
373 will decline (Deutsch et al. 2018, Riegler 2018).
- 374 b) Supplies of potable water will decline.
- 375 c) The average standard of living will decline, probably with a continuously
376 increasing unevenness of access to resources.
- 377 d) Human immigration pressures will increase dramatically, mostly directed
378 to those places on the planet that retain the highest levels of access to
379 the remaining resources.
- 380 e) Health maintenance levels and average life expectancies will diminish.
- 381 f) The prevalence of disease outbreaks and pandemics will increase
382 (Pongsiri et al 2009). In part this will be due to progressive diminution
383 and loss of favorable gut microbiota, especially in urban areas.
384
- 385
- 386 (Dominguez Bello et al. 2018).
- 387 g) The proportion of individuals with debilitating mental illnesses will
388 increase along with a general increase in the proportion of folks unhappy
389 with their living conditions.
- 390 h) Earthquakes will increase in numbers as a result of the proliferation of
391 injection wells (Goebel et al. 2018). These wells generate significantly
392 destructive earthquake activity up to 30 km distance from the wells.

- 393 i) The Earth's climate will continue to warm into the foreseeable future
394 (Naff, 2016) leading to increasing instances of extreme weather conditions
395 (Murakami et al. 2018).
- 396 j) Saltwater intrusion into coastal communities, sometimes for many
397 kilometers, will endanger coastal forest wetlands (Gewen 2018), modify
398 greenhouse gas emissions, increase methane production, and jeopardize
399 coastal real estate values (Worth and Dahl 2018).
- 400 k) Increasing ocean acidification will endanger marine life compromising
401 an extremely important source of food for humans.
- 402 l) Concentrations of methane, a powerful climate altering compound has
403 nearly tripled in the atmosphere since 1800 and is expected to continue
404 increasing driven by many causes, especially by agriculture and use of
405 fossil fuels (Mikaloff, Fletcher and Schaefer 2019, Voosen 2016, Voosen
406 2019).
- 407 m) Extinction rates for the Earth's biota will continue to increase
408 alarmingly (Stokstad (2019).
- 409 n) Insect biomass has declined dramatically in Germany (Vogel 2017), and
410 this may be a prelude for similar trends elsewhere.
- 411 o) Rapid expansion of infrastructure, such as roads, to support human
412 population growth will generate multiple hazards for humans and the
413 rest of the global biota (Laurance et al. 2014, Laurance 2019).
- 414 p) Criminal activity in general will increase (Weinstein et al. 2015) as well
415 as both domestic and international terrorism.
- 416 q) Governments at all levels will become more authoritarian.
- 417 r) Social groupings above the levels of neighborhoods and small towns will
418 become increasingly xenophobic.
- 419 s) Pressure for recreation will increasingly and negatively impact protected
420 areas.
- 421 t) Support for education and basic research will decline as they are
422 threats to dictatorships.

423

424 VI. GUIDELINES

425 Here are six guidelines for all concerned citizens of this planet that summarize
426 recommended approaches for achieving a sustainable human civilization. In
427 addition, please note that Kopnina et al. (2016) have provided a most welcome

428 list of human behaviors that non-coercively will help to guide us to population
429 stability.

430 1) Pay attention to scientific understanding, and support future research. To
431 make this effective, scientists need to do their part by making the effort
432 to explain their findings in ways that can be understood by educated
433 non-scientists and especially by government leaders.

434 2) Remain as optimistic as the evidence permits. No one wants to
435 contribute time and financial support to lost causes, even if they are
436 presented as important for various reasons. On the other hand, optimism
437 encourages enthusiastic support for even difficult but important
438 programs.

439 3) Maintain respectful dialog with as large a component of the Earth's
440 citizenry as possible. While local and regional projects are important for
441 improving limited areas, and for education of residents and visitors, in
442 the long term we will not succeed without significant cooperative
443 involvement of all parts of Earth. We need to encourage the recent
444 trends toward eliminating gender, ethnic, and racial biases in all aspects
445 of human civilization. All women of reproductive age should have access
446 to the tools needed to prevent unwanted pregnancies. Relevant to
447 human population growth, it is important to note that when women have
448 control over their reproductive activities, they typically make choices that
449 are appropriate to their social and environmental circumstances.
450 Population numbers then become stabilized. It is also critical for all sex-
451 related decisions that all world citizens have access to education at least
452 through the secondary school level.

453 4) Encourage cooperation and democracy in the organizational structure of
454 social, governmental, and other groupings of various sizes and
455 complexity. The Earth is full of countries with various levels of autocratic
456 governments, and therefore we know that autocrats are not cooperative.
457 Their primary job is maintaining their personal power. The welfare of
458 their citizenry is low on their priorities, and may even be absent.
459 Moreover, maintenance of the natural environment that in the long run
460 supports their government may also be ignored or perhaps be exploited

461 for monetary gain. Unfortunately, many countries, including the USA, are
462 moving in the direction of autocracy, or are already there.

463 5) Be constantly aware of finding the appropriate balance of activities that
464 support both the common good and those that enhance individual
465 fitness. This dual support is essential for survival of social species such as
466 *Homo sapiens*. However in some countries, including the USA, this duality
467 is rarely mentioned and is certainly not emphasized. When it is
468 mentioned, at least in the United States, it generally is put in terms of
469 making money for the rich and large corporations versus unselfish giving
470 to the poor. These behaviors are justified as appropriate capitalism on the
471 one hand and admirable charity on the other. Recently, another tactic is
472 to give to the financially poor and call it “socialism.” Of course it is
473 socialism but in some countries, such as the US, this name is translated to
474 unacceptable communism. Meaningful support for the financially
475 stressed is threatened or absent, and yet is important to find ways to
476 keep those struggling with financial poverty as contributing members of a
477 democratic society.

478 6) Don't underestimate the need for rapid progress in confronting the 20
479 predictions listed above. Cooperative social support is needed now. The
480 current Covid 19 pandemic offers some helpful lessons in social behavior.
481 Cooperation is now widespread and appreciated. Altruism is more and
482 more common. Search for an appropriate vaccine is a worldwide
483 endeavor. Even some corporations are considering giving to the common
484 good. And, as predicted, there are individuals who compromise the
485 cooperative spirit by intentionally not wearing masks when asked to do
486 so, and thereby endangering the larger community in which they are a
487 part. In such a social context, societies would be justified in protecting
488 themselves from such dangers.

489 A final thought: Nine decades ago, Anne Frank gave us this wisdom: “How
490 wonderful it is that nobody need wait a single moment before starting to
491 improve the world.”

492 **VII. REFERENCES**

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