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Eutrophication science: moving into the future.

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15 We were impressed by the timely revisit of the effects of eutrophication in coastal marine
16 systems by Smith and Schindler [1]. We agree that while there has been substantial work
17 towards identifying the causes of regime shifts in coastal systems, our understanding of the
18 drivers is still far from satisfactory. Nonetheless, we feel that a critical point was not
19 addressed in their review; the effects of eutrophication are likely to be substantially altered
20 under future climate conditions. There is a pressing need to understand how local
21 eutrophication and global climate stressors will interact.

22

23 While the effects of combined climate stressors are becoming increasingly well studied in
24 marine systems (e.g. CO₂ and temperature; [2, 3]), it has only recently been recognised that
25 local and global stressors are likely to interact in unpredicted ways [4]. For example, the
26 historical and continuing deforestation of algal canopies in favour of small, fast-growing turfs
27 across the world's temperate coastline is a focus of considerable research [5]. Developing
28 theory explains these shifts as a function of altered water quality that enables the cover of
29 ephemeral turfs to expand spatially and persist beyond normal seasonal limits. Yet, our recent
30 work shows that elevated nutrients and [CO₂] can interact to have positive synergistic effects
31 on algal turfs [6] and suggests that future conditions may exacerbate shifts from canopy to
32 turf-domination. Indeed, understanding the degree to which these global and local stressors
33 will combine to accelerate and expand ecosystem-shifts is of key concern.

34

35 It is noteworthy, however, that the negative effects future [CO₂] may be substantially reduced
36 in the absence of elevated nutrients [6] and effective local management may help to mitigate
37 the effects of climate change. For example, preventing the harvest of herbivorous fish may
38 suppress algal growth and increase the resilience of coral reefs to climate induced bleaching
39 events [7]. Likewise, we argue that reducing the input of nutrient rich wastewater into coastal

40 marine systems may increase their resilience to phase shifts. In South Australia, the
41 government is implementing policy to recycle 45 % of Adelaide’s wastewater. By removing
42 nutrient stress in near-shore marine systems, this recycling program will not only act as a
43 long-term recovery “experiment” that builds on a 30 year dataset documenting the large-scale
44 decline of kelp forests [8] (filling a scientific gap identified by Smith and Schindler [1]) but
45 will also assess the potential for enhancing resilience of these systems to the deleterious
46 effects of future climates.

47

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