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Supplementary material

Effects of common carp on water quality and submerged vegetation: results from a short-term mesocosm experiment in an artificial wetland

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Additional details for methods

Selection of sites for enclosure construction

To select enclosure locations within blocks, we conducted a GIS exercise utilising lidar water depth profiles to identify 15-m^2 grid cells within the pond's wetted perimeter that were unlikely to dewater. We used the *sample* function in R (R Foundation for Statistical Computing, Vienna, Austria, see https://www.R-project.org/) to generate a prioritised list of potential enclosure sites within each preliminary block, and constructed enclosures partially or entirely within grid cells based on their rank order. A total of eight sample plots comprising seven enclosures and one reference plot (sham enclosure with no walls) were selected in each block.

Enclosure construction details

The 21 walled enclosures (0.02 ha, 14.1 m per side) were constructed during autumn 2017. Enclosure sides were nylon-reinforced, clear plastic sheeting (12 mil Tuff Scrim, Americover, Escondido, CA, USA) supported every 3.5 m by metal fence posts driven into the substrate. Enclosure sides were fastened to fence posts with heavy-duty UV-resistant plastic cable ties, and seams where the ends of sheeting met (encircling the enclosure) were sealed with butyl tape and cable ties. To seal the enclosure at the bottom, a ~0.3-m skirt of the enclosure wall extending outward was secured to the pond substrate along the bottom perimeter. To do this, we cut strips of metal stakes from large (1.2 × 4.9 m) feedlot panels made of 4-gauge wire, such that tines measuring 13–20 cm were spaced every 15–23 cm along a wire backbone. The tines of the strip of metal stakes were pushed through the plastic skirt and part way into the substrate. The cables of small earth anchors (Duckbill model 40-DB-1, Forestry Suppliers, Jackson, MS) were looped over the wire backbone every 0.75–1 m along the stake strip, and the head of the earth anchors were driven through the plastic skirt and into the substrate using a metal driving rod and fence post driver such that the stake strip pulled the plastic skirt into pond bottom and sealed the enclosure. Sandbags were used to reinforce the skirt, hold the stake strip in place, and seal any gaps. With sides raised, the top edge of each enclosure was ~1.5 m above the pond bottom. To secure the enclosure for winter and protect it from damage by ice and wind, the enclosure sides were pushed down to the waterline and secured with plastic cable ties. The enclosures remained in this secured position from October 2017 to June 2019.

Nutrients and water quality

Field data collection

Before use, all 1-L plastic sample pitchers were soaked for 30 min and cleaned with phosphate-free Liquinox detergent (0.1% Liquinox), rinsed with tap water, rinsed with 5% HCl, rinsed with double-distilled (DD) water, air-dried, and placed in individual plastic bags to avoid contamination. A clean pitcher was used for each enclosure. At each quadrant the pitcher was rinsed three times with enclosure water. A fourth collection was used to perform three rinses of a clean 1-L plastic Nalgene collection bottle. Next, the 1-L sample was collected with the pitcher and poured into the pre-rinsed collection bottle, and the collection bottle was then placed on ice inside a cooler. Personnel responsible for the collection of nutrients always wore two layers of Nitrile gloves were always warn

during sample collection (clean hands/dirty hands protocol; US Environmental Protection Agency 1996) to prevent sample contamination, and new gloves were used for each enclosure.

On the first day of each monthly sampling event, a QA/QC sample was collected by taking a 4-L bottle of inorganic blank water (ACS Reagent Grade, 18 mΩ, Ricca Chemical Co., Arlington, TX, USA) to the study site and processed like an enclosure water sample.

Laboratory processing and analyses

In the wetlab at Malheur NWR, the sonde sensors were rinsed three times with composite sample water by consecutively filling the probe cap, affixing the cap, gently shaking the sonde, discarding the rise water, and then filling the cap a fourth time with composite water and recording the measurements. The sonde's sensors were rinsed with DD water between composite samples.

We generally collected one set of sonde measurements and analytical samples from the composite water sample. However, to confirm composite samples were adequately mixed and to evaluate variability of analytical results from the same water samples, we collected triplicate split samples from composites at least once for each enclosure during the study. When triplicate samples were collected, the average value of the three samples was used for data analyses.

Submerged aquatic vegetation

SAV surface area coverage

We used flight planning software (Tower, 3DR) to program the UAS to execute repeatable, autonomous flights over the study area. The MicaSense camera takes images on five bands: blue (centre wavelength 475 nm), green (560 nm), red (668 nm), Red Edge (717 nm), and near infrared (840 nm). After creating the ROIs representing water surface coverage within enclosures or reference plots, they were exported as shapefiles. We then created training data for classification of aquatic vegetation and water (non-vegetated) by selecting 50–75 training records (areas of vegetation ~50–100 pixels in size) across all enclosures. In selecting training records, we used information from all camera bands to help identify vegetation. We repeated this process to create a set of training records for water. We ran a maximum likelihood supervised classification routine to assign individual pixels as vegetation or water, based on highest probability of being in a particular class, and saved the resulting classified raster orthomosaic as a .DAT file. The classified raster was imported into ArcMap, and the ROI shapefile was used to split the classified raster into individual enclosures or reference plots which were then saved as .TIF files. The classified split raster files (.TIF) were imported into ENVI, and the Quick Stats feature was used to extract the relative surface coverage of vegetation within each enclosure. The workflow to process the imagery and perform the supervised classification was repeated for each monthly flight.

Size and growth of common carp and water depths

Table S1. Length (TL) and weight of common carp at stocking and recapture in enclosures at Windmill Pond in 2019 by biomass treatment group, block, and enclosure.

							Stocking		Recapture		
Number	Trt.	Block	Encl.	PIT HDX	PIT FDX	Date	TL (mm)	Wt (g)	Date	TL (mm)	Wt (g)
1	50	A	Y5	DDE409	96AE78	28-Jun	422	935	1-Oct	435	1280
2		B	F13	DDEB62	9645ED	29-Jun	425	960	1-Oct	483	1650
3		C	I14	DC2858	963633	29-Jun	440	1045	1-Oct	480	1500
4		A	W4	DDEB7C	966508	28-Jun	200	135	1-Oct	276	340
5			W4	DDE60D	964647	28-Jun	200	122	1-Oct	272	350
6			W4	DC2843	97B4E7	28-Jun	412	750	1-Oct	435	1015
7		B	Q8	DDE63D	960D65	29-Jun	195	114	30-Sep	281	365
8			Q8	DDE9CA	9660F1	29-Jun	215	160	30-Sep	289	405
9			Q8	DDEB74	962BB5	29-Jun	383	735	30-Sep	440	1260
10		C	Q9	DDE5B6	970BD1	28-Jun	181	89	30-Sep	246	270
11			Q9	DC2881	9610F7	28-Jun	195	113	30-Sep	259	280
12			Q9	DDE566	967060	29-Jun	405	790	30-Sep	435	1065
13	100	A	W7	DDE537	96CEA9	28-Jun	619	2250	1-Oct	631	2825
14		B	D15	DC2835	9654BB	28-Jun	558	1910	1-Oct	570	2765
15		C	Q6	DDE493	976517	28-Jun	580	2035	30-Sep	597	2810
16		A	X5	DDE69D	96B055	28-Jun	211	158	/		
17			X5	DC2856	9647C9	28-Jun	202	136	/		
18			X5	DDE5A5	9718B7	29-Jun	410	845	/		
19			X5	DDE4D1	972111	29-Jun	420	880	/		
20		B	C17	DDE9CF	96443E	28-Jun	198	110	30-Sep	291	425
21			C17	DDE682	96C47D	29-Jun	420	930	30-Sep	464	1295
22			C17	DDE5B7	97206C	29-Jun	416	980	30-Sep	461	1465
23		C	I15	DC2816	963713	28-Jun	189	109	30-Sep	291	390
24			I15	DDE413	96EDDE	29-Jun	357	695	30-Sep	413	1150
25			I15	DC285F	96FEFB	29-Jun	345	475	30-Sep	408	970
26			I15	DDEA4A	95EFAC	29-Jun	445	1150	30-Sep	492	1705
27	300	A	V7	DC2898	966F62	28-Jun	800	6650	1-Oct	810	7950
28		B	J5	DDE5EB	96FC4F	28-Jun	798	6580	30-Sep	805	7210
29		C	I17	DDE5DF	972458	29-Jun	720	4540	1-Oct	721	6200
30		A	Y2	DDE586	96D853	29-Jun	196	113	1-Oct	264	305
31			Y2	DDEB80	969927	29-Jun	210	146	/		
32			Y2	DDEB1F	961B7D	29-Jun	615	2965	1-Oct	626	3705
33			Y2	DDE52F	961139	29-Jun	610	2735	1-Oct	610	3325
34		B	E14	DC28A6	975611	28-Jun	235	210	1-Oct	320	615
35			E14	DC2836	95F0FB	28-Jun	183	86	29-Sep	277	330
36			E14	DC28B8	96C4C8	29-Jun	690	3800	29-Sep	709	4210
37			E14	DDE410	96C488	29-Jun	590	2075	29-Sep	610	2395
38		C	F19	DDE471	96F2D5	28-Jun	225	165	29-Sep	301	395
39			F19	DC28CE	962C1D	28-Jun	220	165	29-Sep	305	435
40			F19	DDE9D8	96F8CA	29-Jun	640	3205	29-Sep	651	3675
41			F19	DDEA05	96B6A5	29-Jun	560	2085	29-Sep	536	2415

Treatment group (Trt.) is carp biomass (kg ha^{-1}), and rows where multiple entries for an enclosure (Encl.) are multiple-fish treatments. The two types of PIT tags implanted were 23-mm half duplex (HDX, prefix 384.3515-) and 12-mm full duplex (FDX, prefix 3DD.0077-); for brevity only the last six characters of each PIT code are shown.

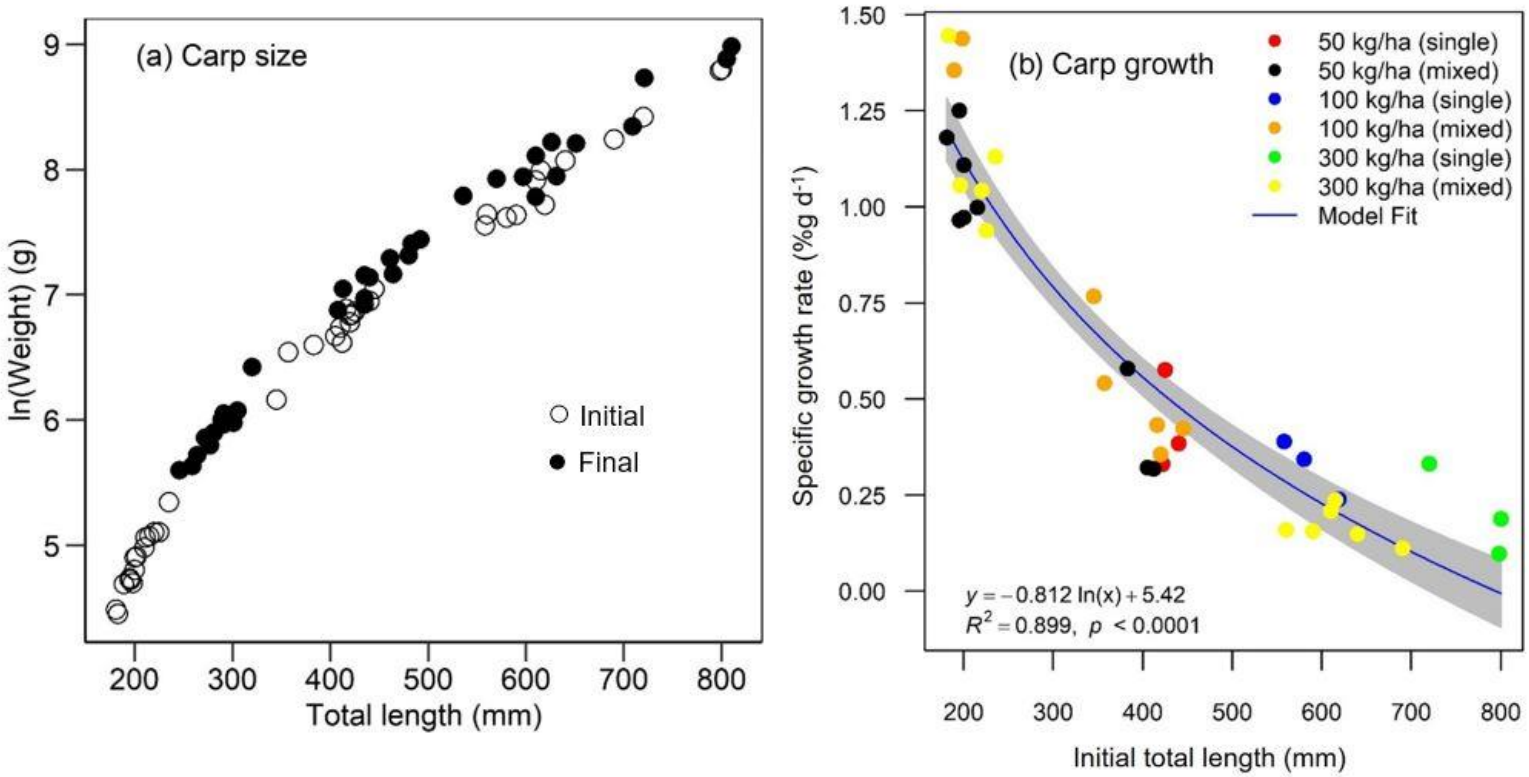

Fig. S1. (a) carp initial (open circles, n = 41) and final size and weight (closed circles, n = 36), and (b) specific growth rate of carp by initial length and treatment group with the non-linear regression fit and (blue line) and 95% CL (grey band).

Table S2. Average water depth in enclosures and reference plots the beginning (28–29 June 2019 (initial), and end of the study in 26 September–1 October 2019 (final)).

			Average water depth SD (cm)	
Carp biomass treatment (kg ha^{-1})	Block	Enclosure	Initial	Final
Reference plot (open)	A	Y4	85 ± 5	49 ± 11
	B	I7	141 ± 11	100 ± 9
	C	G19	93 ± 5	57 ± 8
0	A	T9	92 ± 7	54 ± 6
	B	D18	107 ± 18	70 ± 16
	C	H17	98 ± 6	63 ± 5
50	A	Y5	96 ± 6	56 ± 6
		W4	95 ± 27	61 ± 22
	B	F13	92 ± 5	50 ± 5
		Q8	78 ± 10	44 ± 12
	C	I14	88 ± 15	53 ± 15
		Q9	109 ± 2	71 ± 3
100	A	W7	101 ± 10	65 ± 5
		X5	108 ± 7	69 ± 5
	B	D15	84 ± 3	45 ± 0
		C17	113 ± 10	69 ± 11
	C	Q6	77 ± 2	38 ± 7
		I15	105 + 4	68 + 5
300	A	V7	98 ± 5	56 ± 7
		Y2	89 ± 1	51 ± 3
	B	J5	95 ± 16	57 ± 17
		E14	88 ± 3	49 ± 4
	C	I17	107 ± 1	69 ± 2
		F19	91 ± 3	63 ± 10

Spatial variation and enclosure effects

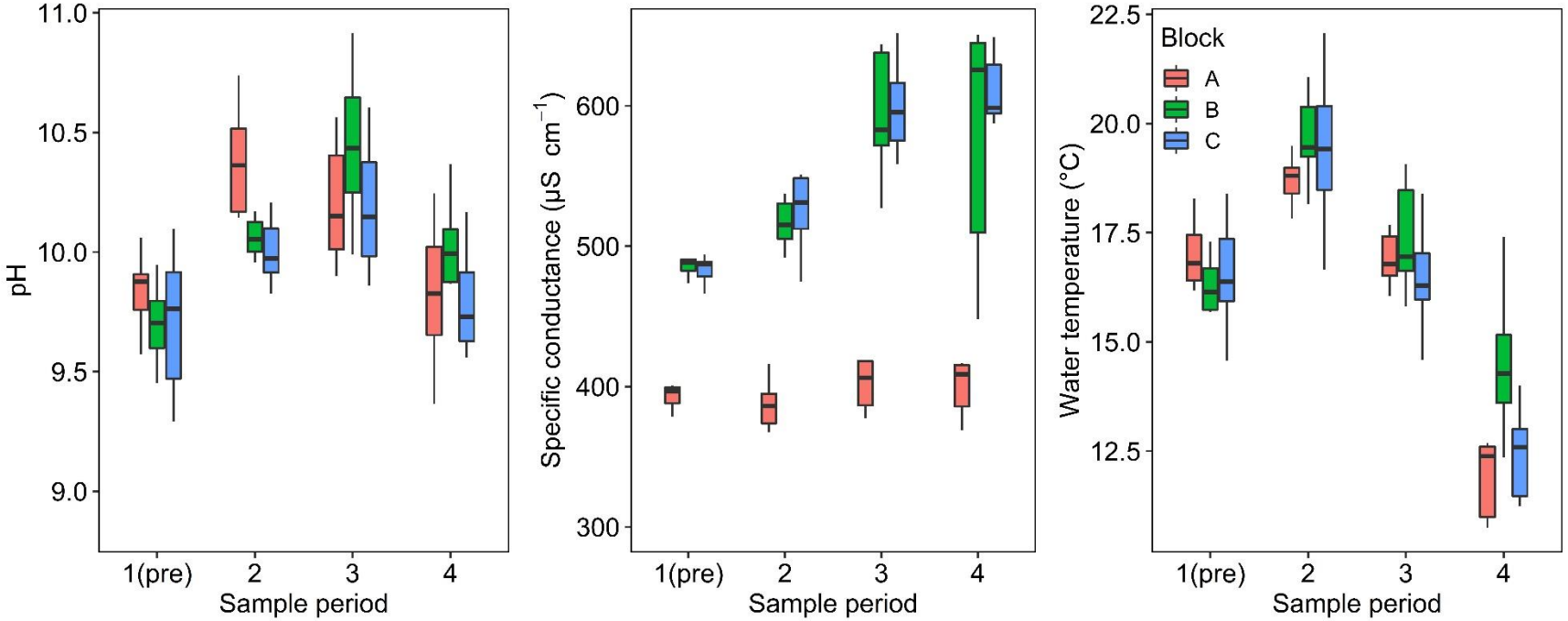

Fig. S2. Box and whisker plot showing pH, specific conductance, and water temperature measured in enclosures at Windmill Pond on four sample occasions between late June and late September 2019. For each plot, the middle bar is the mean, box hinges are 25 and 75% percentiles (first and third quartiles), and whiskers extend to the largest or smallest value no further than 1.5 times the interquartile range.

Spatial variation attributed to blocks

Methods

After fitting a mixed or simple regression model to a dependent variable (see main paper, Table 2), we performed linear contrasts to compare the marginal means among blocks while averaging over the other independent variables to understand the extent of spatial variation in response variables among enclosures and reference plots within Windmill Pond.

Results

Spatial variation in water quality and nutrient concentrations were largely attributed to enclosures in block A, closest to the pond's water source. Averaged over time and carp treatments, metrics related to water clarity (chlorophyll-*a*, total suspended sediments (TSS), turbidity) were significantly lower in block A compared to blocks B or C; nutrient measures NO_x-N, TN, and TP exhibited the same spatial variation (Fig. S3). Ammonium and PO_4-P were lower in block A compared to block C and block B respectively. By contrast, mean SiO_4 concentration and the soluble P:TP proportions were higher in block A than one or more of the other blocks. Averaged over sample period, surface water coverage of SAV was greater in block C than in block B.

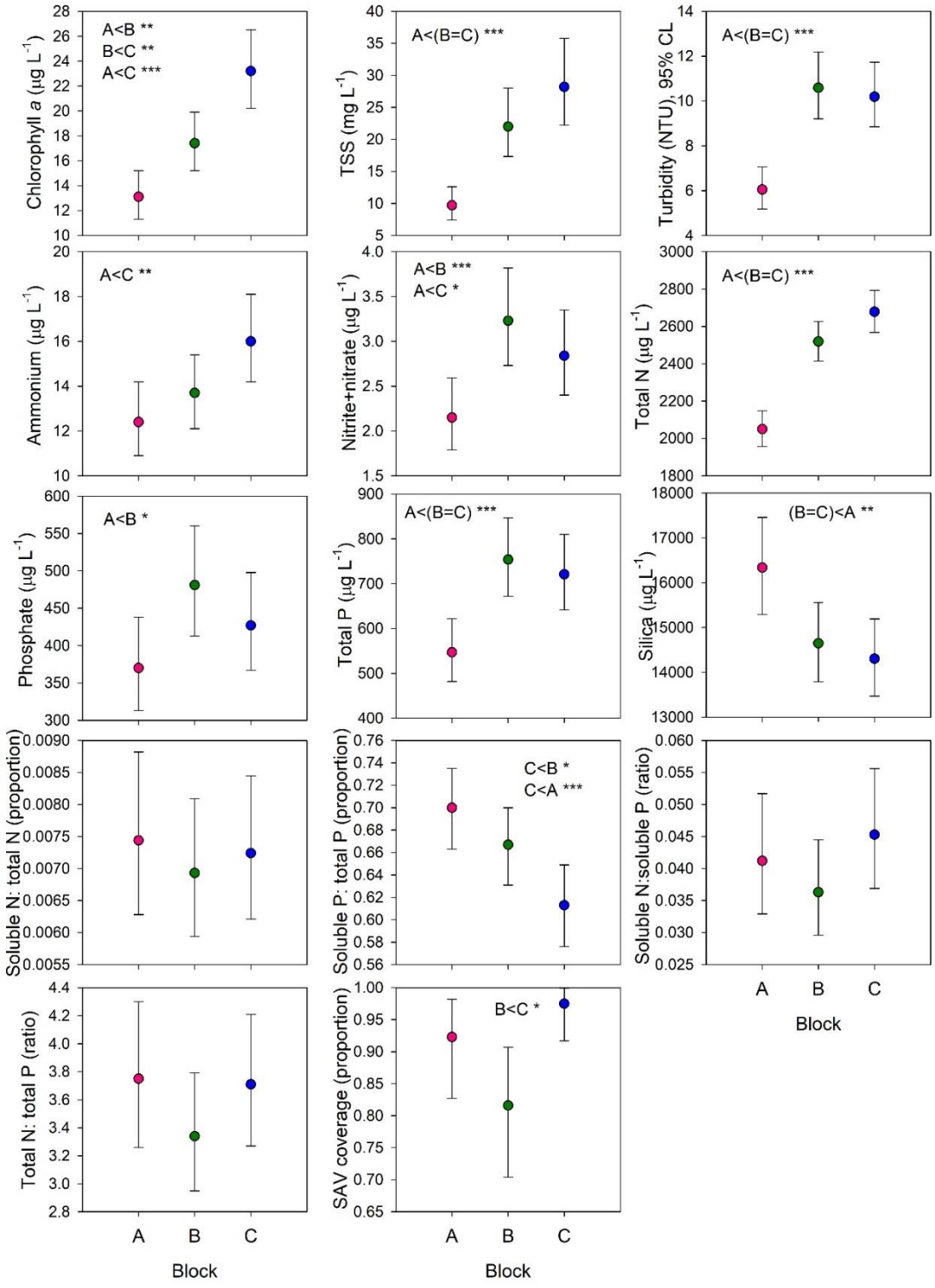

Fig. S3. Marginal mean (± 95% CI) water quality (chlorophyll *a*, turbidity, TSS), nutrient concentrations, nutrient ratios, and SAV water surface coverage, by block. Estimates are based on the models in Table 2 of the main paper. *P*-values of linear contrasts evaluating spatial differences (block effects) are so noted on each panel where: *, $P < 0.1$; **, $P < 0.05$; and ***, $P < 0.01$.

Enclosure effects

Methods

After fitting a mixed or simple regression model to a dependent variable (see Table 2), we performed linear contrasts to compare the marginal means of the reference plots to marginal means of the 0 biomass control enclosures for each sample period to determine whether there were enclosure effects resulting from isolating water within enclosures.

Results

We found statistically significant differences between reference plots and 0 biomass control enclosures in one or more sample periods for 9 of 14 of the time-series variables (Table S3). Marginal mean chlorophyll *a* concentration was 10.1–22.1 µg L^{-1} higher in the controls during the final two sample periods, exhibiting the temporal trend expected for an enclosure effect whereby conditions in controls and reference plots and diverged through time. Similarly, average TN in controls was marginally greater (by 539 µg L^{-1}; $P = 0.11$) in the third sample period, and 984 µg L^{-1} higher in the fourth. Total P and PO_4-P concentrations in controls and reference plots appeared to diverge through time with higher values in reference plots as the study progressed. However, the observed differences in marginal means for TP and PO_4-P were statistically significant only in the second period, when concentrations were 398 and 419 µg L^{-1} greater in reference plots, respectively). The relative concentration of silica ($Si0_4$) in controls and reference plots also exhibited a temporal trend, and was ~42% (4,929 µg L^{-1}) higher in controls at the end of the study. The mean soluble N:TN ratio – though very low overall – diverged through time and was more than twice as high in reference plots (1.6×10^{-2}) than in controls (7.3×10^{-3}) during the final sample period. The TN:TP ratio also diverged following the initial sample and was 83–108% higher in controls, on average (Fig. 7), but the differences were marginally significant in the last two sample periods ($P = 0.11$).

There were a few cases where the temporal pattern in differences among controls and reference plots could not be attributed entirely to an enclosure effect. Mean soluble N:TP was statistically greater in reference plots (range 0.5–0.68) than in enclosures (0.71–0.81) in every sample period, which suggests differences could have been due – at least in part – to initial conditions. Surface coverage of SAV exhibited the same pattern of differences in every sample (though in the opposite direction); coverage was always higher in controls (range of marginal means = 0.93–0.99) than in reference plots (0.70–0.80) suggesting an effect of initial conditions. Mean soluble N:soluble P was marginally greater in controls (by 4.5×10^{-2}, $P = 0.145$) during the second sample period, but the values were statistically indistinguishable in subsequent samples and no obvious temporal trend in differences was apparent. In general, the analyses of potential enclosure effects suggested the most conservative approach for analysing treatment effects of carp was to use the zero biomass control for comparisons and not to combine reference plots and zero biomass enclosures into a single ‘control’ group.

Table S3. Linear contrasts evaluating enclosure effects on the marginal means of water quality, nutrients, derived variables and surface coverage of submerged aquatic vegetation (SAV).

Dependent variable	Linear contrasts by time, marginal means (95% CI)
Chlorophyll-*a* (µg L^{-1})	T3: 11.0_{ref} (8.1–15.1) < $20.1_{0\ kg}$ (14.6–27.5) **
	T4: 18.1_{ref} (13.2–24.8) < $40.2_{0\ kg}$ (29.4–55.1) **
TSS (mg L^{-1})	–
Turbidity (NTU)	–
NH_4-N (µg L^{-1})	–
NO_x-N (µg L^{-1})	–
Total N (µg L^{-1})	T3: 2350_{ref} (2048–2697) < $2889_{0\ kg}$ (2518–3315) [P = 0.11]
	T4: 2313_{ref} (2016–2655) < $3297_{0\ kg}$ (2873–3783) **
PO_4-P (µg L^{-1})	T2: $178_{0\ kg}$ (108–293) < 597_{ref} (363–981) **
Total P (µg L^{-1})	T2: $365_{0\ kg}$ (249–532) < 763_{ref} (522–1114) **
$Si0_4$-Si (µg L^{-1})	T4: 11 754_{ref} (9656–4307) < 16 $683_{0\ kg}$ (13 706–20 307) *
Soluble N:TN (µg L^{-1})	T4: $7.3 \times 10^{-3}{}_{0\ kg}$ (5.1×10^{-3}–1.1×10^{-2}) < $1.6 \times 10^{-2}{}_{ref}$ (1.1×10^{-2}–2.2×10^{-2}) **
Soluble P:TP	T1: $0.68_{0\ kg}$ (0.56–0.78) < 0.81_{ref} (0.72–0.88) *
	T2: $0.50_{0\ kg}$ (0.38–0.62) < 0.79_{ref} (0.69–0.86) ***
	T3: $0.51_{0\ kg}$ (0.38–0.63) < 0.71_{ref} (0.59–0.80) **
	T4: $0.50_{0\ kg}$ (0.38–0.63) < 0.77_{ref} (0.66–0.85) ***
Soluble N:Soluble P	T2: $2.6 \times 10^{-2}{}_{ref}$ (1.3×10^{-3}–5.0×10^{-3}) < $7.1 \times 10^{-2}{}_{0\ kg}$ (3.6×10^{-2}–1.3×10^{-1}) [P = 0.145]
TN:TP	T2: 2.6_{ref} (1.7–3.9) < $5.4_{0\ kg}$ (3.6–8.1) *
	T3: 2.9_{ref} (1.9– 4.4) < $5.4_{0\ kg}$ (3.6–8.1) [P = 0.11]
	T4: 2.9_{ref} (2.0–4.4) < $5.3_{0\ kg}$ (3.5–8.0) [P = 0.11]
SAV coverage	T1: 0.70_{ref} (0.45– 0.90) < $0.93_{0\ kg}$ (0.75–1.0) [P = 0.134]
(proportion)	T2: 0.80_{ref} (0.56– 0.96) < $0.99_{0\ kg}$ (0.87–1.0) [P = 0.134]
	T3: 0.70_{ref} (0.45– 0.90) < $0.99_{0\ kg}$ (0.92–1.0) **
	T4: 0.74_{ref} (0.49– 0.93) < $0.99_{0\ kg}$ (0.87–1.0) *

The 'Enclosure effect' contrast compares differences between the 0 biomass control enclosures (0 kg) and the reference plots (ref) at each sample period (T1–T4). Codes for statistical significance (P-values) of ratio contrasts are: *, $P \leq 0.1$; **, $P < 0.05$; and ***, $P < 0.01$. Generally, '–' denotes not statistically significant at $\alpha = 0.1$, but there are few cases where contrasts were close to this threshold and the exact P-value is given in brackets. Subscript on the marginal mean (e.g. ref, 0 kg, single) denote the group involved in the contrast, where 'ref' are reference plots and '0 kg' are enclosures without carp (0 biomass controls).

Additional data on submerged aquatic vegetation (SAV)

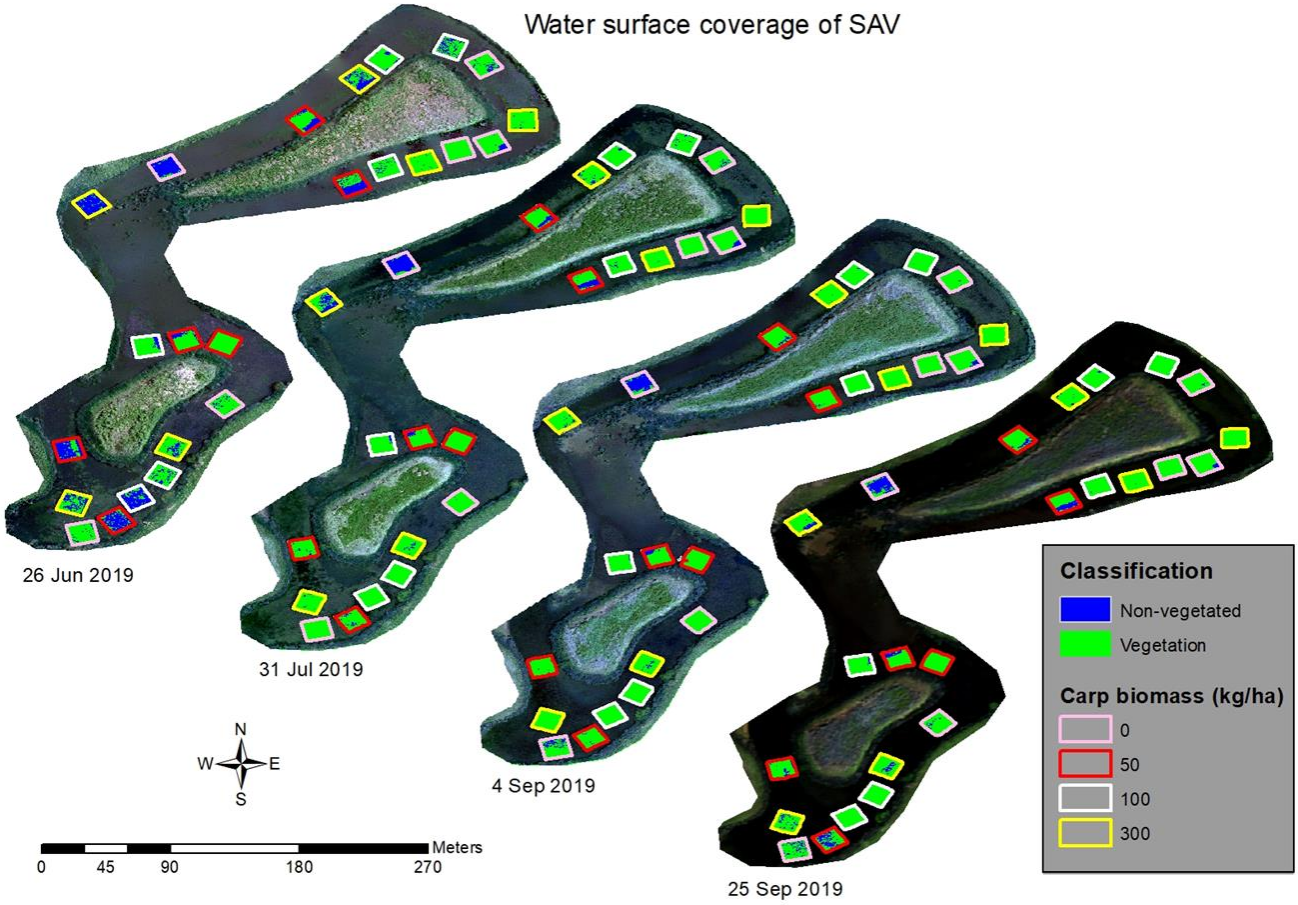

Fig. S4. Graphical depiction of water surface coverage of submerged aquatic vegetation (SAV) based on classification of a time-series of aerial images collected by an unmanned aerial system (UAS). Individual pixels (5 cm) were classified as vegetation or non-vegetated based on a supervised classification analysis, and enclosures are colour-coded by carp biomass treatment. See the 'Additional detail for methods' section for additional information about enclosures.

Table S4. Water surface coverage of submerged aquatic vegetation (SAV), taxonomic composition, and species dominance based on ocular surveys; and SAV dry biomass based on rake sampling during 25 Sep–1 Oct 2019.

				SAV in Enclosure (4 plots)			SAV in plot with biomass sample	
Carp biomass (kg ha^{-1})	Block	Fish comp.	Encl.	Ocular surface coverage average (s.d.)	Taxa present in canopy or understorey (number of plots present)	Simpson's λ in canopy (s.d.)	Ocular surface coverage estimate	SAV dry biomass (g m^2)
Ref	A	-	Y4	0.91 (0.11)	Myr (4), Stu (2)	0.96 (0.06)	0.98	380.9
	B	-	I7	0.66 (0.28)	Myr (4), Stu (2)	0.97 (0.06)	0.9	166.2
	C	-	G19	0.95 (0.10)	Myr (4), Stu (1), Pot (1)	0.99 (0.02)	1	473.8
0	A	-	T9	0.94 (0.11)	Myr (4), Stu (2), Pot (2)	0.99 (0.03)	1	278.9
	B	-	D18	0.95 (0.10)	Myr (4), Stu (3), Pot (1)	0.94 (0.05)	1	395.1
	C	-	H17	0.98 (0.03)	Myr (4), Stu (2)	0.98 (0.05)	1	483.7
50	A	S	Y5	0.71 (0.29)	Myr (4), Stu (4), Pot (1)	0.84 (0.14)	0.92	192.3
		M	W4	1.0 (0.00)	Myr (4), Stu (4)	0.99 (0.01)	1	180.3
	B	S	F13	0.90 (0.20)	Myr (4), Stu (3)[A], Pot (1), Unk (1)	0.92 (0.14)	1	552.2
		M	Q8	0.88 (0.25)	Myr (4), Stu (4)[A], Unk (1)	0.85 (0.24)	1	389.1
	C	S	I14 [B]	0.74 [B] (0.31)	Myr (4), Stu (3)[A]	0.86 (0.18)	1	467.8
				-	-		0.54	411.7
				-	-		0.4	68.3
		M	Q9	1.0 (0.00)	Myr (4), Stu (2), Pot (1)	1.00 (0.01)	1	439.6
100	A	S	W7	0.95 (0.06)	Myr (4), Stu (4), Pot (2)	0.90 (0.07)	0.9	291.2
		M	X5 [C]	0.91 (0.03)	Stu (4), Myr (4) Pot (3), Cha (1)	0.74 (0.20)	0.95	221.5
	B	S	D15	0.95 (0.10)	Myr (4), Stu (3), Pot (1)	0.98 (0.01)	1	536.2
		M	C17	0.96 (0.03)	Myr (4), Stu (4)[A]	0.88 (0.15)	1	311.3
	C	S	Q6	1.0 (0.00)	Myr (4), Stu (3), Pot (2)	0.97 (0.04)	1	579.2
		M	I15	1.0 (0.00)	Myr (4), Stu (2)[A], Pot (2)	0.92 (0.16)	1	352.6
300	A	S	V7	0.86 (0.13)	Myr (4), Stu (4), Pot (2)	0.89 (0.02)	0.95	312.3
		M	Y2	0.99 (0.02)	Myr (4), Stu (4)	0.99 (0.01)	1	235.6
	B	S	J5	0.94 (0.09)	Myr (4)[D], Stu (4)[D], Pot (2), Cha (1)	0.75 (0.18)	1	314.1
		M	E14	0.98 (0.05)	Myr (4), Stu (4)[A]	0.92 (0.08)	1	266.6
	C	S	I17	0.96 (0.03)	Myr (4), Stu (1)	1.00 (0.01)	1	389.9
		M	F19	1.0 (0.00)	Myr (4), Stu (2)	1.00 (0.01)	1	598.6

Average SAV coverage and taxa present are based on estimates from four 1-m^2 plots per enclosure or reference plot (200 m^2 in total area). Generally, a single plot per enclosure was randomly selected for sampling of SAV biomass, and the corresponding ocular estimate of SAV coverage is listed for that plot. There was one enclosure (I14) where we report SAV biomass data for three plots. Fish composition (Fish comp) indicates whether single (S) or multiple (M) fish comprised the carp biomass treatment. Plant taxa are listed in rank order of surface coverage. Abbreviations are: Myr, *Myriophyllum* (milfoil); Stu, *Stuckenia* (thin-leaf pondweed); Pot, *Potamogeton* (broad-leaf pondweed); Cha, *Chara* (algae); and Unk, unknown taxa. Unless otherwise noted, *Myriophyllum* was the dominant taxa, and all other taxa were sparse with <10% surface coverage in plots where they were present on the surface or were represented by one or a few plants when present in the understorey.

[A]Surface coverage for taxa was 10–30% within one of the four 1-m^2 plots.

[B]Enclosure had four plots for ocular estimates, but only three plots for SAV biomass.

[C]All four fish escaped from enclosure so data were not analysed.

[D]*Myriophyllum* covered 90% of the surface in 2 of 4 plots. Surface coverage of *Myriophyllum* was equal to *Stuckenia* (50% each) in the plot where biomass was measured, and *Stukenia* coverage was 70% in the fourth plot.

Reference

US Environmental Protection Agency (1996). Method 1669: Sampling ambient water for trace metals at EPA water quality criteria levels. Environmental Protection Agency, Washington, DC, USA.