



Figure 1. Meadow Creek Pond

Fish Stocking Patterns versus Abundance of Double-crested Cormorants at Suburban Ponds in Northern Utah

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Frequency of Trout Stocked

Jensen Nature Park Pond

Table 1

Year	Total Trout Stocked	Trout-Stocking Events	Average Trout size (cm)	Days with 0 Cormorants	Peak Cormorant Number	Average \pm SD Cormorants per day
2017	3251	1	23.62	2	28	7.13 \pm 7.69
2018	3494	4	24.41	0	13	5.16 \pm 2.74

Quantity of Trout Stocked

Steed Pond

Table 2

Year	Total Trout Stocked	Trout-Stocking Events	Average Trout size (cm)	Days with 0 Cormorants	Peak Cormorant Number	Average \pm SD Cormorants per day
2017	2003	2	23.70	9	18	3.45 \pm 4.07**
2018	1497	2	24.10	26	1	0.16 \pm 0.37**

Size of Trout Stocked

Meadow Creek Pond

Table 3

Year	Total Trout Stocked	Trout-Stocking Events	Average Trout size (cm)	Days with 0 Cormorants	Peak Cormorant Number	Average \pm SD Cormorants per day
2016	4198	3	24.41	6	8	2.29 \pm 1.75*
2017	4047	3	23.62	9	7	1.77 \pm 2.00*
2018	2363	2	36.70	22	8	1.43 \pm 1.67*

No Trout Stocked

Maybe Pond

Table 4

Year	Total Trout Stocked	Trout-Stocking Events	Average Trout size (cm)	Days with 0 Cormorants	Peak Cormorant Number	Average \pm SD Cormorants per day
2017	0	0	-	22	2	0.35 \pm 0.61
2018	0	0	-	21	3	0.39 \pm 0.67



Figure 2. Cormorants at Steed Pond

Results & Discussion

Throughout the study, peaks in cormorant numbers tended to follow trout-stocking events (Fig. 3). At Jensen Pond, increased stocking frequency in 2018 vs. 2017 distributed trout more evenly through the season at roughly the same number & size, accompanied by a lower peak cormorant count & somewhat fewer cormorants per day (Table 1). At Steed pond, stocking fewer total trout at a similar frequency to 2017 corresponded with more zero-cormorant days, lower peak cormorant counts, & significantly fewer cormorants per day in 2018 (Table 2). At Meadow Creek Pond, stocking fewer, larger trout in 2018 was associated with more zero-cormorant days & significantly fewer cormorants per day (Table 3). In contrast, Maybe pond did not receive trout during either study period & always had low cormorant numbers, including >20 no-cormorant days both years (Table 4). Collectively, these observations suggest smaller, more frequent stockings of larger trout could reduce cormorant impacts.

It is common for fish stocking events to attract cormorants (e.g. Kumada et al. 2013) & this has held true within Utah (e.g. Modde et al. 1996). In addition, it has recently been argued that reduced trout-stocking density does not reduce angler satisfaction (Hyman et al. 2016). Further, stocking larger trout can increase angler satisfaction at limited extra expense (Losee & Phillips 2017). Hence, we suggest integrating these approaches could reduce cormorant impacts & improve angler experience.

References

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Introduction

The Double-crested Cormorant (*Phalacrocorax auritus*) is a piscivorous bird inhabiting North America. They are powerful swimmers, diving to catch fish. Although once endangered, the Double-crested Cormorant population has exploded & encroached on formerly abandoned & new territories throughout the USA. Cormorant foraging on sport & commercial fishes is now a management concern (Dorr & Fielder, 2016).

We studied the abundance of cormorants in relation to the trout stocking in small suburban ponds, Northern Utah. Sowards et al. (2016) previously documented heavy predation by cormorants on stocked rainbow trout (*Oncorhynchus mykiss*). They also found evidence that cormorant numbers increased in response to trout stocking. Padilla et al. (2018) observed that stocking a larger number of trout corresponded with an elevated abundance of cormorants. We hypothesized that stocking larger trout (~30 cm) or decreasing the number stocked at one time, but stocking more frequently, could reduce overall cormorant presence at these ponds.

Methods

We observed four ponds in Weber & Davis counties for 30 min per pond through May & June 2018, between 7:00 & 10:30 AM each day. We visited ponds on a rotating schedule, starting with a different pond each day to reduce bias potentially caused by differing observation times. The Utah Department of Natural Resources Wildlife Division (UDWR) stocked rainbow trout & channel catfish (*Ictalurus punctatus*) into the ponds.

At each pond visit, we censused cormorants, including those foraging or resting on shore (Figs. 1-2). In 2018, the UDWR modified trout stocking patterns, decreasing number per stocking, increasing stocking frequency, & stocking larger trout in some cases. Modifications varied by pond (Tables 1-3).

We compared our data with those from former surveys to summarize trends in cormorant abundance by year as days with zero cormorants, peak daily cormorant count, & mean cormorants per day (Tables 1-3). We compared mean cormorants per day by year with a two-sample T-test assuming equal variances (Maybe, Jensen, & Steed ponds) & a one-way ANOVA (Meadow Creek Pond).

* $p \leq 0.05$, ** $p \leq 0.0001$

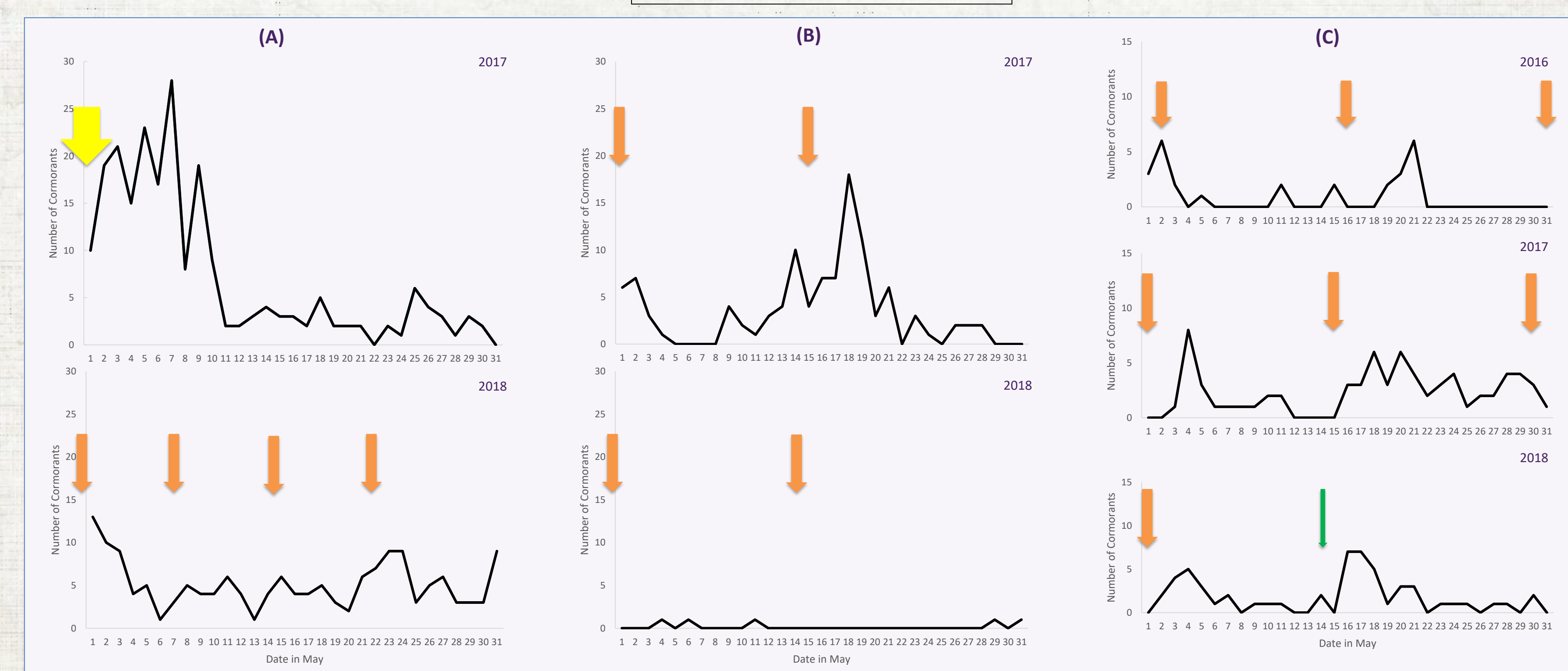


Figure 3. Graphs show number of cormorants present at each pond. (A) represents Jensen Nature Park Pond, (B) represents Steed Pond, and (C) represents Meadow Creek Pond. The yellow arrow represents a larger amount of trout stocking (~1250), the orange arrows represents an average number of trout stocking (~500), and the green arrow represents a small number of trout stocked (~150).