铜陵长江大桥对豚类栖息地的影响

于道平[1]，唐海滨[1]，汪克来[2]
(1. 铜陵白　豚养护场，安徽铜陵　244000；2. 铜陵大桥管理局，安徽铜陵　244000)

摘要：根据 1987～2001 年在铜陵江段所进行的 18 次豚类生态考察，统计历年考察记录中，在成德洲-梅埂段(以下称大桥河段)工作的天数及观察到的白　豚和长江江豚数量，分别计算其 SPUE 值(Sightings per unit of effort，以头/d 计)。并于 1989、2001 年，在长江水位 8.5m 左右(吴淞高程)测定了大桥河段断面 A、B、C、D 的深度(m)及流速(m/s)。根据汉道最大河宽(B)、转折角(α)、曲折率(S/L)、以及汉道宽长比(B/S)的变化，分析河道与沙洲的变动对白　豚和长江江豚栖息地的影响。

研究结果表明大桥建成后，河段平面变形小，汉道分流比稳定，滩槽很少变动，流态稳定，水势复杂多样，仍具备豚类栖息活动必要的水文条件。但铜陵大桥对其上下河道、沙洲也产生了一定的影响，主要表现为近期和悦洲与成德洲附近的滩槽冲淤明显，汇、分流区主流摆动不确定，不能形成稳定的水区，导致成德洲附近的白　豚和长江江豚活动次数明显减少。特别是白　豚的活动路线中(太阳洲→梅埂)的羊山矶，历次考察中未观察到白　豚。总而言之，白　豚在大桥河段的 SPUE 值降低与其种群急剧下降是一致的，但在梅埂活动的次数下降不明显；长江江豚在局部水域(梅埂、横港)的 SPUE 值有上升趋势，这些现象可能与近期的河床演变及桥墩挑流有关。

关键词：铜陵长江大桥；白　豚；长江江豚；河床演变

The Impact of Tongling Yangtze Bridge on the Dolphins' Habitats

YU Dao-Ping[1], TANG Hai-Bin[1], WANG Ke-Lai[2]　(1. *Tongling Baiji Semi-Nature Reserve, Tongling, Anhui, 244000, China*; 2. *Administration Bureau of Tongling Bridge, Tongling, Anhui, 244000, China*). ***Acta Ecologica Sinica*, 2002, 22(12): 2079～2084.**

Abstract: The Tongling River Section, with many zigzag river channel and well-developed sandbars, is one of the few river sections of the Yangtze River where the Baiji (*Lipotes vexillifer*) can be found usually, and Yangtze finless porpoise (*Neophocaena phocaenoides asaeorientalis*) concentrated with relatively high density. However, along with the increase and expansion of human activities, especially the construction of anti-flood, main dams and bridges, the habitat of the Yangtze dolphins has been fragmented and isolated. In order to preserve the critically endangered Baiji endemic to China, in-situ conservation must be enforced besides ex-situ conservation effort, based on the experience and lessons from the domestic and foreign conservation practices of endangered animals.

According to 18 ecological surveys in the Tongling River Section from 1987 to 2001, the sighting per unit of effort (individual/day) in river section Chengdezhou-Meigeng (henceafter the Bridge Section) was estimated based on the survey days and individual numbers observed. The water depth (m) and velocity (m/s) in the Bridge Sections when the water level was 8.5 m at Gaocheng, Wushong, were measured in 1989 and 2001. The influences of the alteration of river channel and sandbars on the Baiji and the Yangtze finless porpoises were analyzed according to the change of the maximum width, angles, refractive index, and ratio of width/length of the branch stream.

Our studies showed that there was only a small change in the water surface, branch streams,

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作者简介：于道平，男，学士，高级工程师。主要从事水生生态和淡水豚保护生物学研究。E-mail：dolthin@mail.tl.ah.163.net

beaches, and water flows after bridge construction. Thus, the Bridge River Section still has the necessary water conditions for the dolphins' inhabiting. However, the Tongling Yangtze Bridge slightly affected the river channel and sandbars in the upper stream and downstream of the Bridge waters. There are many newly silted beaches, and the difference between water convergence and diffluence became unclear. For this reason, the discovery rates of Baiji and finless porpoises in this river section decreased significantly. No Baiji was found around the water of Yangshanji and Heyue islet as surveying in field, where Baiji was feeding along Taiyangzhou to Meigeng. To sum up, the decrease of SPUE in the Bridge Section for the Baiji is consistent with the rapid population decline for Baiji, however, the derease in the Meigeng is not obvious. Rather, in some sections, e.g. Meigeng and Henggang, the SPUE of Yangtze finless porpoise increased to some degree, which is probably in relation to the change of riverbed and water flow caused by the bridge piers. In order to preserve the Baiji and the Yangtze finless porpoises and their habitat in the core area in the Tongling River Dolphins Reserve (i.e. Meigeng and Henggang), it is urgently need to prohibit any illegal activities of fishing operations and sand pickings, and the speed of ships and boats in this waters must be restricted strictly.

Key words: Tongling Yangtze Bridge; *Lipotes vexillifer* (Baiji); *Neophocaena phocaenoides asaeorien talis* (Yangtze finless porpoise); fluvial process

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铜陵江段位于长江下游感潮江段和非感潮江段的结合部,是长江下游常年能发现白 豚(*Lipotes vexillifer*)的为数不多的江段之一,也是长江江豚(*Neophocaena phocaenoides asaeorientalis*)数量较集中、密度较大的水域[1],一直受到中外鲸类学者高度关注[2~5]。

白 豚和长江江豚栖息活动的水区,除生物环境优越外,其水文地理环境通常流态稳定,流速缓慢,处于弯曲江段和弯曲分汊江段的较大回水区[6]。特定的来水来沙条件和汊道进出口节点的控制作用,使分汊河道的流势趋于稳定[7]。葛洲坝及下荆江江段人工裁湾取直工程,使白 豚活动的回水区遭到破坏[8],三峡大坝的建立,白 豚分布上限被迫向下游退缩[9],而界牌河段整治工程有利于白 豚和长江江豚的栖息活动[10]。长江中下游已建大桥 12 座,这些大型水下工程对河势和流态将产生一定的影响,本文通过铜陵大桥建成前后期的水文监测和豚类生态调查,详细研究了白 豚和长江江豚栖息活动与河道变动之间的关系。

1 材料与方法

豚类调查资料主要取自 1986 年后,铜陵白 豚养护场在该江段进行的 18 次考察及部分已发表文献,统计历年考察记录中,在成德洲-梅埂段(以下称大桥河段)工作的天数及观察到的白 豚和长江江豚数量,分别计算其 SPUE 值(Sightings per unit of effort ,以头/d 计)。并于 1989 年、2001 年,分别在长江水位 8.5m 左右(吴淞高程)用超声测深仪(SKIPER-DS_{100},南京产)测定了大桥河段(图 1)断面 A、B、C、D 的深度(m),用流速仪(LS680 旋怀式,重庆产)测定流速(m/s)。采用测距仪测岸上固定目标求汊道最大河宽(B)、以汊道进出口节点(束窄段)的往返航程均值作为汊道曲线长(S),通过平面坐标来计算转折角(α)、曲折率(S/L)、以及汊道宽长比(B/S),根据分汊河段形态指标[11],分析和悦洲与成德洲近期相对稳定性。

2 结果

2.1 大桥河段基本概况

大桥河段呈分汊与单一相间,大桥上游为和悦洲汊道,呈微弯分汊河型,左汊为主汊,深槽偏右。右汊为支汊,主流走向自上游梅埂附近分成两股,分别进入和悦洲左右汊,由于分流区主流远离洲头,因此,30 多年来,洲头 0m 线向上淤展 2km,如果过渡段深槽左摆,对左汊入流有利,反之则改善右汊入流条件。

和悦洲尾至成德洲为单一段,河道顺直,上窄,下宽,羊山矶束窄段附近 0m 河宽为 895m,成德洲分流区最宽达 2520m。深槽靠右,横断面形态呈偏"V"形,逐渐向"W"形过渡。和悦洲左右汊流汇合于大桥上游

2km 处,经右岸羊山矶节点挑流后进入展宽扩散段,主流靠右岸,在成德洲头分流区逐渐开始分成左右两股,主流进入成德洲左汊,支流进入右汊。成德洲汊道为顺直分汊河型,洲头为浅滩。由于干流河段主要受控于上游来水来沙条件的变化,当高水位时主流取直,动力轴线偏左,故左岸河床易冲刷,对成德洲左汊有利;而低水位时,主流挫弯,动力轴线右偏,对右汊有利,左岸河床就局部调整。

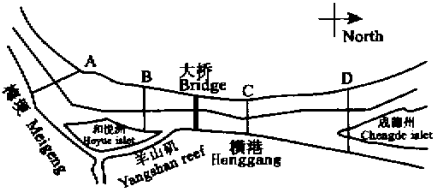

图 1　大桥河段的测量断面

Fig. 1　Measuring section in the water around Tongling Bridge

2.2　河床演变

2.2.1　深槽摆动　大桥上游的主汊为和悦洲左汊,全长 8.5km,建桥前平均河宽 1.0km,河槽以冲刷为主,大桥修建后,受墩台等建筑物的挤压和干扰,大桥上游壅水,使建桥前原有的边滩成藕节型淤积扩大,−20m 深槽上端部分后退 800m,深槽中下部弯顶向左扩大 100～250m,导致主流及河势随之发生较大扭曲(图 2)。

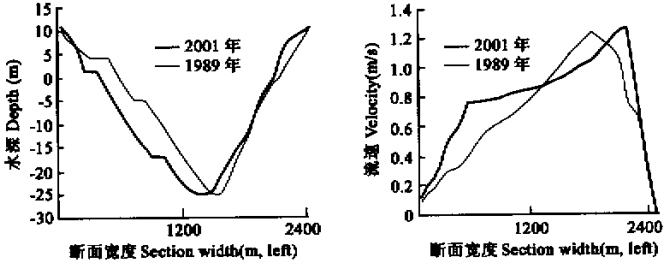

图 2　断面 B 的水深和流速

Fig. 2　Water depth and velocity in section B

大桥下游,由于加大了水面比降,河道主流经羊山矶和 5 号墩的挑流作用,增强了挑流力度,使河槽向左摆动并刷深,河床断面形状由偏“V”形转变为正态“U”形。进入成德洲分流区时,主流开始右摆,最大右摆达 300km(图 3)。

2.2.2　沙洲变化　建桥后,大桥河段的沙洲变化最明显的地方在和悦洲洲头、成德洲洲头及其中后部。由于和悦洲左汊进口端深槽线略向右摆,从而导致和悦洲上游的沙滩左缘 0m 线略有冲刷,最大冲退 250m(图 4)。

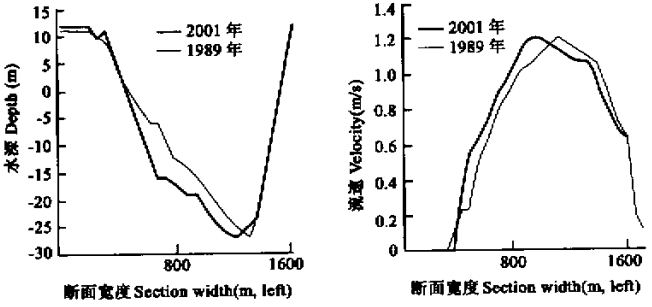

图 3　断面 C 的水深和流速

Fig. 3　Water depth and velocity in section C

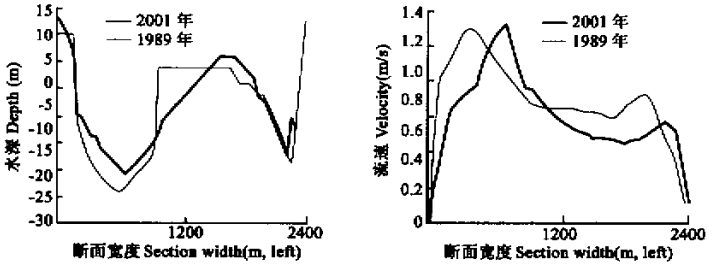

图 4 断面 A 的水深和流速

Fig. 4 Water depth and velocity in section A

建桥后因干流段河道深槽略有上左、下右的摆动，加之分流区受 4～5 号墩束狭水流的影响，水流比建桥前更集中。因此成德洲洲头 0m 线的冲刷后退，分流区－10m 深槽最宽部被冲刷下移约 500m，左汊入口段主流右偏 200m 多，因而导致左汊左岸 0m 线大幅度右移，最大宽度达 500m，上、下范围达 4km 多。与此同时，－10m 槽向成德洲洲头靠拢，洲头及左缘继续冲刷后退 100～200m(图 5)。而成德洲中后部左缘 0m 线大幅度左移，最大宽度达 650～700m，上、下范围达 4.5km 左右。

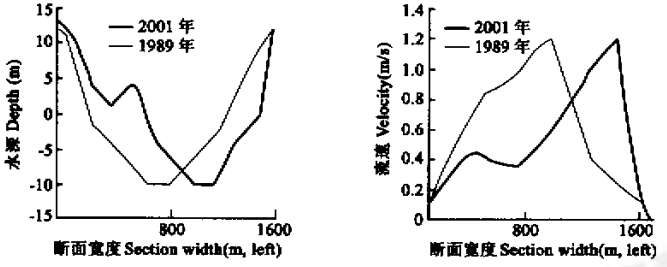

图 5 断面 D 的水深和流速

Fig. 5 Water depth and velocity in section D

近年来，和悦洲略呈左兴右衰的趋势，而成德洲分汊段略有左衰右兴的趋势，因此大桥河段的河势尚处自动调整时期，其分汊河段平面形态参数(表 1)均有变化，表明和悦洲由弯曲型分汊河道向顺直型分汊河道发展，河道稳定性增强；而成德洲的由顺直分汊型河道向弯曲型分汊河道变动，河道的稳定性降低。

表 1 分汊河道的形态参数变化

Table 1 The change of morphological parameters for the branch channels

参数 Parameter	和悦洲 Heyue Islet			成德洲 Changde Islet		
	1989 年	2000 年	差额 Remainder	1989 年	2000 年	差额 Remainder
类型 Type	弯曲型分汊河道 Bent branch channel			顺直型分汊河道 Straight branch channel		
最大河宽 Maximum widths(km)	4.19	3.70	－0.49	5.23	5.62	＋0.39
转折角 Angles α(°)	69.0	65.5	－3.5	19.0	19.2	＋0.2
曲折率 S/L Refractive index	1.18	1.07	－0.11	1.04	1.09	＋0.05
汊道宽长比 B/S Width/length of branch channel	0.430	0.377	－0.053	0.280	0.284	＋0.004
稳定性 Stability	↑			↓		

2.3　豚类栖息活动

2.3.1　白　豚　1987～2001 期间的 15a 中,可分为 3 个时期,即 1987～1991 年(建桥前期),1992～1996 年(建桥期),1997～2001 年(建桥后期),分别统计白　豚在梅埂、和悦洲、羊山矶和成德洲水域的 SPUE 值(图 6)。结果表明白　豚在大桥附近水域活动次数总体上呈下降趋势。建桥后,历次考察中在和悦洲与羊山矶附近没有观察到白　豚,与建桥前期相比,白　豚在成德洲的活动次数明显地降低,但梅埂的 SPUE 值变化不大。

2.3.2　长江江豚　1993～2001 年,在大桥河段共进行 12 次考察,其中 6 次考察记录较详细和完整,3 次考察在大桥建设时期(1993、1994、1995),另 3 次考察在大桥建成后(1998、1999、2000)。这些资料均出自作者野外考察单船记录长江江豚在梅埂、和悦洲、横港和成德洲出现的次数、头数、以及考察天数。结果表明与大桥建设期相比,大桥建成后和悦洲与成德洲的长江江豚 SPUE 明显下降,但梅埂和横港的长江江豚 SPUE 值急剧上升(图 7)。

图 6　白　豚在大桥水域的 SPUE

Fig. 6　SPUE of Baiji in the waters around Tongling Bridge

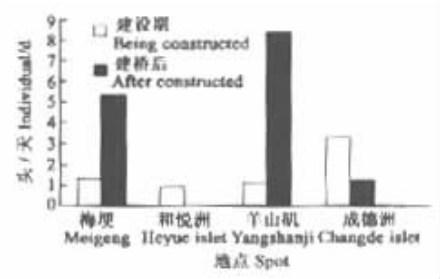

图 7　长江江豚在大桥水域的 SPUE

Fig. 7　SPUE of Yangtze finless porpoise in the waters around Tongling Bridge

3　讨论

3.1　根据大通站 1950～1985 年的水、沙实测资料,水沙通量有明显的季节性变化,其中沙通量的变化更为显著,因此铜陵江段冲淤一般规律是:淤积发生在汛期,主要集中在洪水淹没的岸滩和汊道段广阔的浅滩,落淤的绝大部分是悬沙;落水时出现冲刷,冲刷部位主要在中低水位以下的浅滩和深槽[12]。加之羊山矶挑流节点良好的导控作用,以及和悦洲头 0m 线上移和巩固,大桥上游的汇、分流区主流的摆动受到限制,所以大桥河段平面变形小,汊道分流比稳定,滩槽很少变动,且流态稳定,水势复杂多样,仍具备作为白豚栖息地必要的水文条件。

3.2　1998 年特大洪水可能对和悦洲洲头与成德洲洲头的冲刷有一定的影响,但大桥建成后,大桥河段的流态与河床不稳定性已初见端睨,根据能量最小假说,分汊河道会自动调整[7]。由于大桥下游的汇、分流区主流摆动不确定,因此近期成德洲附近的滩槽冲淤明显,不能形成稳定的水区,导致成德洲头的白　豚和长江江豚活动次数明显减少。建桥以后,在历次考察中羊山矶附近没有观察到白　豚,推测受南岸的桥墩阻碍,羊山矶挑流减弱,下游不能形成大面积的回水区。

3.3　1987～2001 年期间,白　豚在梅埂活动的次数下降不明显,而长江江豚 SPUE 值近年来在局部水域(梅埂、横港)呈明显上升趋势,究其原因,梅埂水域沙床在淤积发育中,底层流速趋缓,有机物和悬浮物相对集中沉降,是鱼类索饵活动地方;后者由于横港北岸有大范围的缓流水区,加之矶头、桥墩挑流作用,大桥下游形成复杂的马蹄形漩涡水系,在沟壑中形成静水区可供豚类栖息活动。因此,建立铜陵淡水豚自然保护区是适时的、必要的,在保护区内建立法规和管理条例,加强环评,对核心点(如梅埂和横港)一定要取缔非法渔具、禁止采砂及船舶限速通行,从而最大限度地保护好白　豚和长江江豚的栖息环境。

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